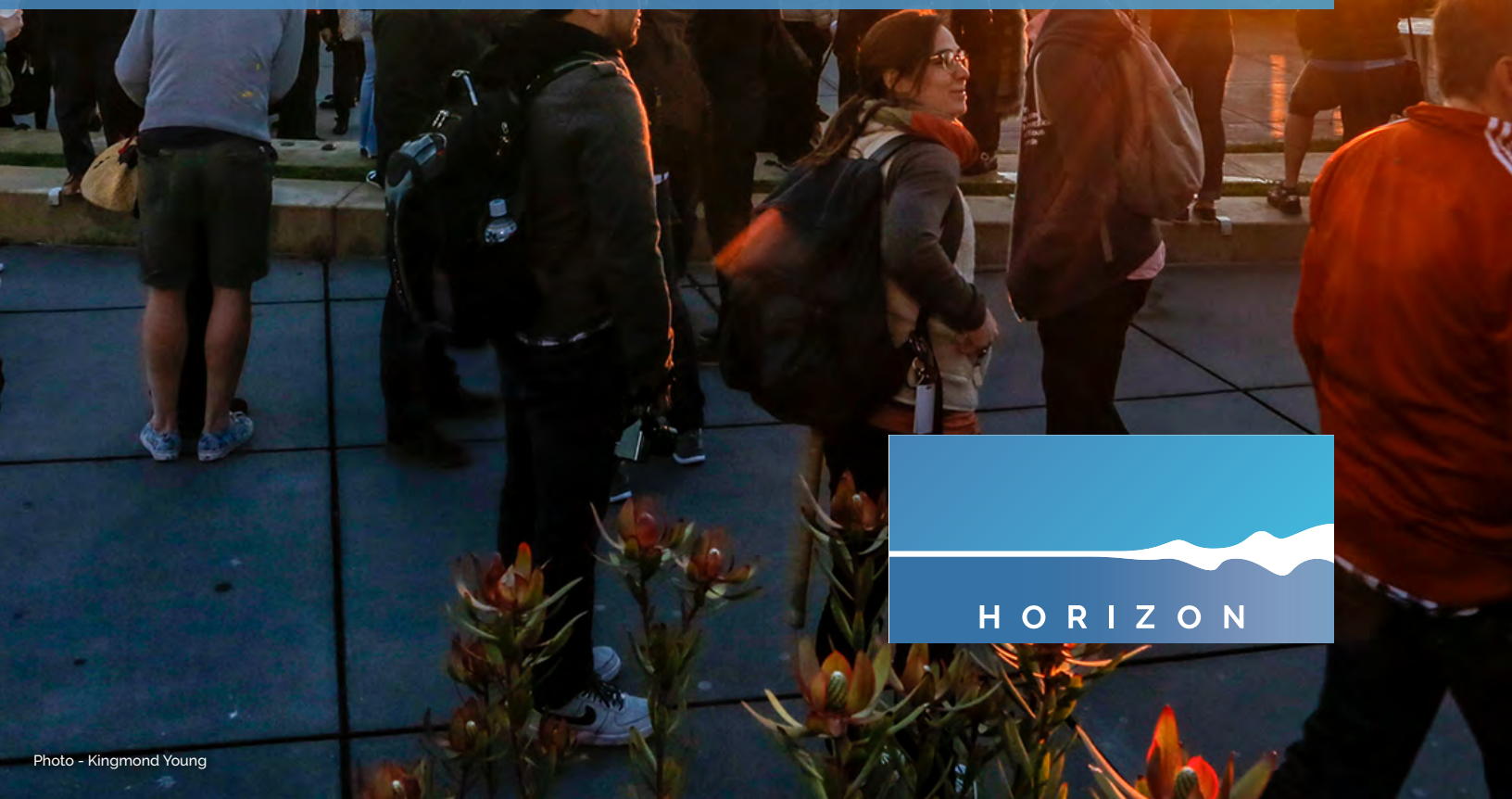
FUTURES FINAL REPORT

RESILIENT AND EQUITABLE STRATEGIES FOR THE BAY AREA'S FUTURE

JANUARY 2020



HORIZON

Photo - Kingmond Young

HORIZON

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JANUARY 2020

ASSOCIATION OF BAY AREA GOVERNMENTS
METROPOLITAN TRANSPORTATION COMMISSION

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CONTENTS

January 2020

In 2018 and 2019, the Metropolitan Transportation Commission (MTC) and the Association of Bay Area Governments (ABAG) conducted a new type of long-range planning process, known as Horizon. The Horizon initiative underscored that the future is incredibly uncertain and that these uncertainties pose a wide range of challenges for the Bay Area's future. To move toward a Bay Area that is affordable, connected, diverse, healthy and vibrant for all, new strategies will be needed in the years ahead.

Building upon the Futures Interim Report – published in March 2019 – this Futures Final Report explores how a potential suite of transportation, housing, economic and environmental strategies could put the Bay Area on a more resilient and equitable path forward over the next 30 years. As a scenario planning exercise, Horizon was not intended to act as a near-term legislative platform or call to action, but instead to identify strategies that might best position the Bay Area for success. Both the Futures themselves and the strategies explored through this process should be considered with this context in mind.

Through the lens of three distinct and divergent Futures, the Horizon initiative generated new and creative ideas. It engaged thousands of Bay Area residents and a wide range of stakeholder organizations in prioritizing potential policies and investments. Finally, it conducted robust analyses to "stress test" many of these potential solutions to the Bay Area's thorniest problems. Ultimately, this process has culminated in a suite of recommendations on how to build a stronger foundation for Plan Bay Area 2050, the next regional long-range plan currently underway.

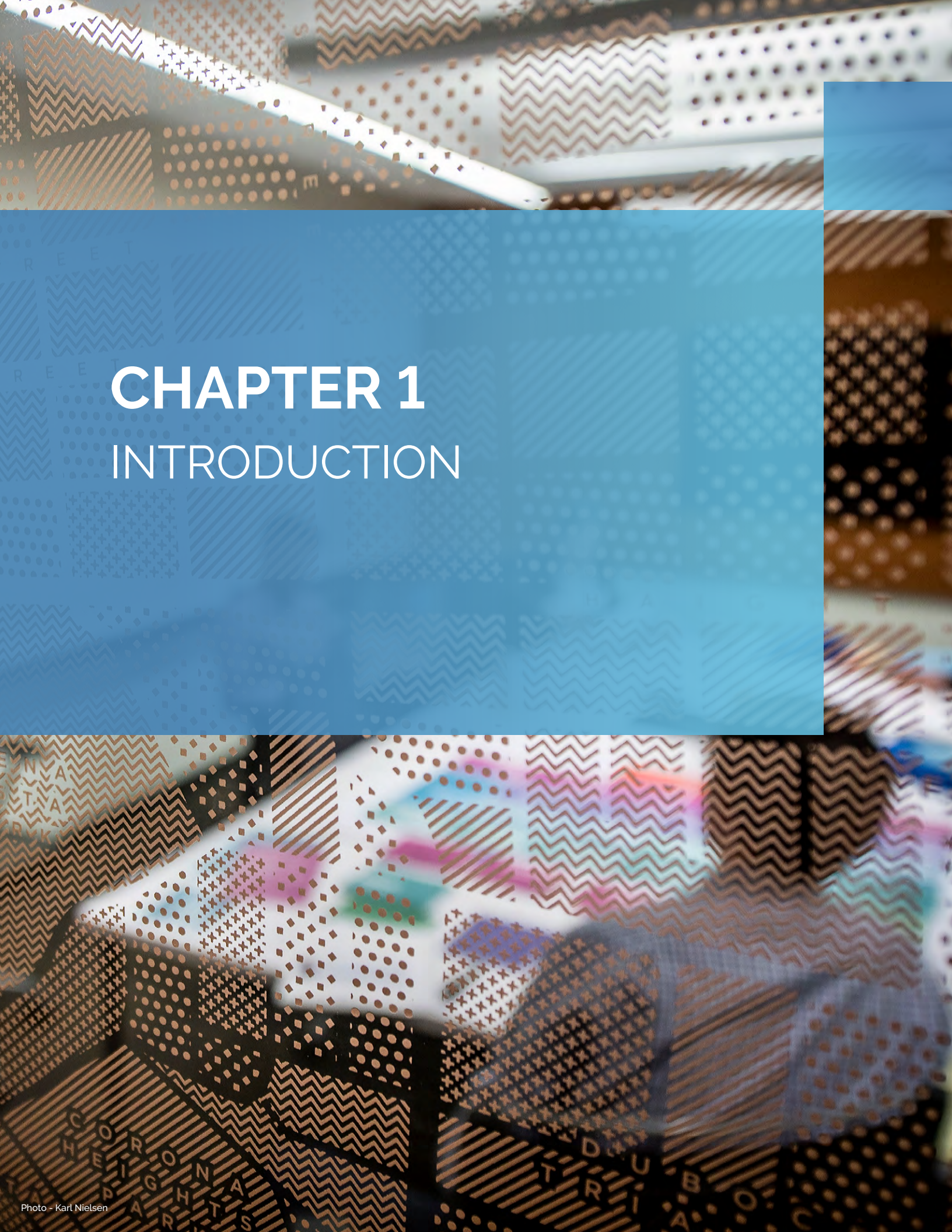
While this report reflects the conclusion of the Horizon planning process, it also represents the beginning of critical conversations, which will stretch through much of 2020. Should the Bay Area encourage housing development in a broader range of geographies – beyond Priority Development Areas – to achieve equity and sustainability goals? How should the Bay Area weigh tradeoffs between critical transportation investments, especially if new revenues become available? And how can local jurisdictions and the region work together to fund critical needs to prepare for sea level rise and earthquakes?

This report seeks to inform this dialogue in the months ahead. Through ongoing engagement with the public at large, disadvantaged communities, local jurisdictions, community organizations and other public agencies, we look forward to your continued involvement in planning for the Bay Area's future through Plan Bay Area 2050 and beyond. Together, we can tackle the challenges of today and prepare for the uncertainty of tomorrow.

Sincerely,

Therese W. McMillan
Executive Director

CHAPTER 1
INTRODUCTION



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INTRODUCTION

When we plan for the future, what sort of future are we planning for? Disruptive technologies, rising sea levels, economic booms and busts, political volatility, and various other external forces may fundamentally alter the future of the San Francisco Bay Area. To explore a range of challenging questions that traditionally have been outside the regional planning process, the Metropolitan Transportation Commission (MTC) and the Association of Bay Area Governments (ABAG) developed a new initiative, called Horizon, to explore pressing issues Bay Area residents may face through 2050. Horizon leveraged new techniques in exploratory scenario planning, embracing uncertainty as a central element of the planning process.

This Futures Final Report culminates the Horizon initiative, bringing together the strategies identified in a suite of Perspective Papers and scenario- and project-level analyses with robust public outreach. This report aims to provide key insights into how to make the Bay Area more resilient and equitable in the decades ahead by identifying the most effective strategies and investments in an increasingly uncertain world. The findings included in this report are intended to inform elected officials, stakeholders and the general public as we plan for the future of the Bay Area over the next year. With recommendations for transportation, housing, economic and environmental strategies, the Futures Final Report will play a key role in establishing a firmer foundation for Plan Bay Area 2050, the next long-range plan for the San Francisco Bay Area.

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Work Elements of Horizon

The past two years of the Horizon process included four core work elements:

Futures Planning: Central to Horizon was the development and study of three divergent what-if scenarios called "Futures." Futures Planning explored divergent scenarios to identify how a range of forces will potentially shape the Bay Area. Futures Planning transcended previous scenario planning efforts by including a greater variety of political, technological, economic and environmental challenges that impact the lives of Bay Area residents. The Futures Planning process included two rounds of analysis, the first of which was summarized in the Futures Interim Report (published March 2019). This Futures Final Report summarizes the second round of that work, while also drawing from Horizon's other three work elements.

Perspective Papers: A series of white papers, known as Perspective Papers, explored strategies for issue areas previously outside the scope of past long-range planning processes. Each paper proposed a set of priority strategies for further exploration in the Futures Planning process, of which a subset of high-priority strategies was vetted by the public and then assessed in the second round of Futures Planning.

Project Performance Assessment: Similar to prior planning cycles, Horizon included a robust Project Performance Assessment for major transportation investments. The assessment identified costs and benefits of different transportation projects in each of the three Futures mentioned above. The Project Performance Assessment was designed to help policymakers and partners make data-driven decisions about future transportation investments in an era of uncertainty, in parallel with the strategies analysis done for Futures Planning.

Public Outreach: Finally, Public Outreach wove together all the components of Horizon, providing an opportunity for community members to provide input on the most effective strategies and investments to address current and future regional challenges. Staff hosted workshops, convened "pop-up" forums at community events, hosted committee meetings and webinars, and attended events hosted by community-based organizations to hear from as many voices as possible.

Throughout the Horizon process, MTC and ABAG explored both challenges and opportunities that lie ahead for the Bay Area – and what we can do now to prepare for them. While this report integrates content from all phases of Horizon, it focuses primarily on analysis of the three Futures, as well as the efficacy of strategies analyzed in each Future. The information can help guide the public, partners and elected officials in considering the best strategies to improve regional outcomes. Ultimately, these strategies should help ensure the advancement of the Horizon Guiding Principles – to make the Bay Area more affordable, connected, diverse, healthy and vibrant in the years ahead. These five Guiding Principles were developed with Bay Area residents in spring 2018, and they represent the organizing framework for Horizon.

How Horizon Informs Plan Bay Area 2050

Horizon is a "blue sky" planning initiative that is intended to better prepare the Bay Area for the future and to build a stronger foundation for Plan Bay Area 2050. Similar to Horizon, Plan Bay Area 2050 will tackle transportation, housing, economic and environmental challenges through the year 2050. By conducting Futures Planning work, Horizon was designed to help identify the strategies that MTC Commissioners and ABAG Board Members may want to consider as part of Plan Bay Area 2050. These strategies will help address significant regional issues like housing affordability, overcrowded transit systems, jobs-housing imbalances and rising sea levels, among others.

It is important to underscore that this is an exploratory scenario planning exercise and that, while extensive public engagement was used to prioritize strategies for analysis, the MTC and ABAG governing boards have not endorsed the strategies being analyzed. This Futures Final Report makes recommendations related to a shortlist of strategies for further consideration, based on their relative performance. Rather than representing recommendations of strategies to implement, this report is intended to inform discussion by the boards in the coming months as part of the first phase of the Plan Bay Area 2050 process. Time still remains for more discussion on these strategies and for further refinement of the subset of strategies that may be advanced into the Plan Bay Area 2050 Blueprint.

CHAPTER 2

FUTURES PLANNING

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FUTURES PLANNING

Futures Planning is a departure from past scenario planning efforts in the San Francisco Bay Area. Past versions of Plan Bay Area engaged residents in a conversation about "which scenario do you prefer?" Each scenario had the same forecasted employment and population growth, with the difference being how growth was dispersed and how transportation investments were prioritized. After several cycles of repeating the same scenario planning approach, a high-level regional consensus emerged: the Bay Area generally wants to prioritize focused growth in existing communities, maintain our aging infrastructure and construct strategic expansions to allow for new transit-oriented development.

These areas of shared consensus have produced critical gains – such as the rapid decline of greenfield development on critical farmlands – but significant regional challenges also remain, requiring identification of new strategies in the long-range plan. Horizon presented an opportunity to delve into complex and uncertain topics like sea level rise or new technologies, for which a regional consensus has not yet emerged nor potential strategies been fully explored at the regional scale.

As a result, the process and key questions for Horizon were fundamentally different from past scenario planning efforts because they were designed to integrate the reality of an uncertain future. Importantly, the goal of Futures Planning was not to pick a preferred Future but rather to use three distinct Futures with a variety of different conditions as backdrops to test the resilience of different strategies. The key question in the Futures Planning process was, "which strategies that could be advanced by local jurisdictions, regional agencies or the state in the coming decades are effective under a variety of uncertain conditions?"

Photo - Karl Nielsen

Over the 18-month Horizon planning effort, the Futures Planning element consisted of two phases of analysis, each beginning with public input into the process:

1a. Collaboratively create three divergent Futures to explore in the first round of analysis.

(February 2018 through July 2018)

Through a day-long peer exchange in April 2018 with subject matter experts in different disciplines from across the Bay Area, followed by a comment period for Horizon stakeholders, MTC and ABAG developed a universe of eleven Futures that were then narrowed down to three divergent, or markedly different, Futures for further exploration. Defined by over two dozen external forces beyond the Bay Area's control, each Future incorporated assumptions about the year 2050, such as changes to the national population growth rate, the rate of autonomous vehicle adoption and the extent of sea level rise. The full set of studied external forces are described in greater detail in the next section.

OUTCOME: Identified three Futures, defined by a set of external forces, to study in the first analysis round.

1b. Analyze and simulate how the Bay Area would fare in each Future – assuming no changes are made to current regional or local strategies.

(July 2018 through February 2019)

MTC and ABAG conducted analysis of the three Futures, projecting future conditions through year 2050 for the San Francisco Bay Area. Three different forecasts, one for each Future, were developed, that incorporated economic, land use and transportation projections. Each analysis started with the same baseline conditions and assumed the same set of strategies from the Bay Area's most recently adopted long-range plan, Plan Bay Area 2040 (adopted by MTC and ABAG in 2017). The only difference between the three Futures analyzed in this round were the set of external forces. The first round of analysis studied how Plan Bay Area 2040 fared in an era of greater uncertainty, and identified opportunities and challenges the Bay Area may face when confronted with previously unstudied external forces.

OUTCOME: Futures Interim Report – Opportunities and Challenges

2a. Collaboratively identify strategies to address the challenges posed by each Future.

(March 2019 through May 2019)

At workshops, MTC and ABAG staff received input from elected officials, partners and Bay Area residents on new strategies they thought would most improve outcomes in each Future. This phase of the process drew directly from the other key elements of Horizon – Perspective Papers and Project Performance. Participants were asked to prioritize a subset of strategies from a larger list previously developed in Horizon Perspective Papers and from packages of transportation projects submitted through the Project Performance Assessment process. Using workshop input and committee refinement, a set of 35 strategies was selected to test in the final phase of Horizon.

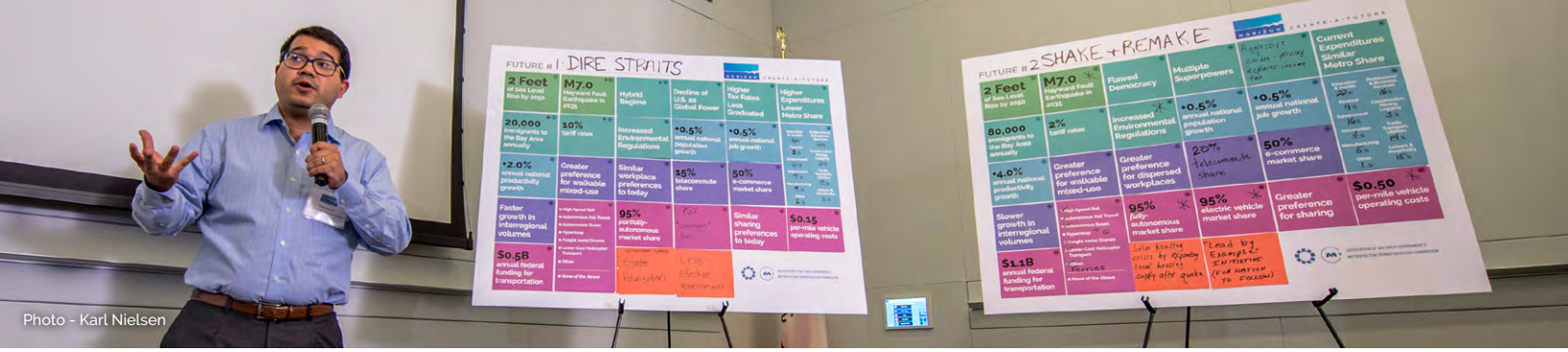
OUTCOME: Identified three sets of strategies (one set for each Future) to study in the second analysis round.

2b. Collaboratively identify strategies to address the challenges posed by each Future.

(June 2019 through October 2019)

Once the set of 35 strategies was selected, MTC and ABAG staff reanalyzed these strategies in the context of the three Futures. This analysis identified the efficacy of the strategies in improving regional outcomes as well as which strategies proved most effective across multiple Futures. All strategies were studied as a package for each Future to understand the integrated impacts of the combined strategies, but additional supplemental analyses of individual strategies were conducted to provide additional insight into the driving forces behind key outcomes. The analysis findings are presented in this report. Strategies that proved effective in multiple Futures will be recommended for further consideration in Plan Bay Area 2050.

OUTCOME: Futures Final Report – Resilient and Equitable Strategies for the Bay Area's Future



Components of Horizon Analysis

The Futures Planning process analyzed the three Futures twice (Round 1 and Round 2), resulting in six distinct analyses, each defined by a unique set of components. Each analysis always included three main modeling inputs: (i) the 2015 baseline conditions; (ii) assumptions on external forces, unique to each future; and (iii) a set of strategies to test. Table 1 illustrates the main components that made up each round.

In the Round 1 analysis, the baseline conditions and the Plan Bay Area 2040 strategies were the same, with the external forces acting as the only change. In the Round 2 analysis, the baseline conditions and external forces for each Future remained the same, but a new package of Horizon strategies was developed. In general, the new Horizon strategies were additive to Plan Bay Area 2040 strategies; however, the individual Futures differed in terms of available financial resources, which limited the number of strategies that could be accommodated in each.

Table 1. Components of Futures Planning analysis
The different number of dollar signs for Horizon strategies reflects the smaller, low-cost package studied in Rising Tides, Falling Fortunes, and the larger, more expensive package studied in the other two Futures.

	ROUND 1 ANALYSIS Comparing the three Futures, how does Plan Bay Area 2040 fare in an era of uncertainty?	ROUND 2 ANALYSIS Comparing against Round 1 results, how do new strategies improve each Future?
RISING TIDES, FALLING FORTUNES (RTFF)	2015 Baseline + External Forces (RTFF) + Strategies (PBA 2040)	2015 Baseline + External Forces (RTFF) + Strategies ($Horizon_S$)
CLEAN AND GREEN (CAG)	2015 Baseline + External Forces (CAG) + Strategies (PBA 2040)	2015 Baseline + External Forces (CAG) + Strategies ($Horizon_{SS}$)
BACK TO THE FUTURE (BTTF)	2015 Baseline + External Forces (BTTF) + Strategies (PBA 2040)	2015 Baseline + External Forces (BTTF) + Strategies ($Horizon_{SS}$)

Baseline - Consistent Across All Futures and Consistent Across Both Analysis Rounds

Every analysis began with the same year 2015 starting point, which generally reflected the current conditions in the Bay Area. Current conditions included the composition of the Bay Area economy, the location of jobs and households, and the transportation network as they exist today. Major development and completed infrastructure projects from 2015 through 2019 also were preloaded into the baseline for the first five years of the simulation.

External Forces – Unique For Each Future But Consistent Across Both Analysis Rounds

Each of the three Futures was defined by more than two dozen external forces, with assumptions differing significantly across the three Futures. For each Future, the external forces remained the same across the two rounds of analysis. When creating the Futures at the 2018 peer exchange workshop, participants worked to create logically cohesive sets of forces, woven together by a unified narrative. The three Futures chosen for study were selected because they represented a wide array of possibilities; generally, staff strove to have one Future roughly align with a continuation of trends for a given external force, with the other two Futures exploring divergent bands of possible conditions. The primary exception is the inclusion of a consistent earthquake in all three Futures – a magnitude 7.0 event in year 2035 on the Hayward fault – to understand how the Bay Area might prepare and recover from a major disaster under a wide range of circumstances. Below, a brief narrative describes each Future, highlighting the central external forces that influence the long-term trajectory of the world, the United States and ultimately the San Francisco Bay Area. Table 2 provides detail on the 24 external forces that define each Future.

Rising Tides, Falling Fortunes is defined by relaxed federal regulations and the elimination of federal programs from social services to infrastructure. In this Future, the federal government implements costly tariff policies as well as tight immigration restrictions. As a result, an era of slow growth begins across the United States, with particularly significant impacts in areas like the Bay Area. Labor constraints mean that innovation rates slow, and driverless electric vehicles fail to live up to the hype. Finally, a lack of international leadership means that worst-case sea level rise predictions come true – resulting in 3 feet of sea level rise by 2050.

Clean and Green is defined by an aggressive federal carbon tax to curb carbon dioxide emissions. This Future assumes that the policy is implemented in the early 2020s and results in similar commitments worldwide. Consequently, clean technologies thrive. Driverless electric vehicles become nearly universal, with consumers preferring to share rides more frequently. Virtual reality enables more telecommuting and distributed workplace locations, particularly for higher income individuals. Federal infrastructure investment allows for the completion of high-speed rail lines across the country, including California High-Speed Rail. Yet with high taxes and new regulations, jobs are assumed to be increasingly automated, which boosts productivity but results in fewer openings for workers without college degrees.

Back to the Future is defined by a thriving national economy supported by increased public investment in infrastructure, as well as immigration reform that increases the national population and workforce growth rate significantly. In the Bay Area, the technology sector thrives, leading to broad adoption of low-cost driverless vehicles. As a result, coastal metropolitan areas see a new wave of growth as technologies enable residents to commute longer distances to thriving urban job centers. Silicon Valley technologies remain dominant worldwide in everything from cars to e-commerce. Yet booming growth poses challenges for communities and their aging infrastructure that are absorbing that growth.

Table 2. External forces that define underlying conditions in the year 2050

EXTERNAL FORCES		Rising Tides, Falling Fortunes	Clean and Green	Back to the Future
ENVIRONMENT	Sea Level Rise	3 Feet	1 Foot	2 Feet
	Natural Disasters	2035 Hayward Fault Earthquake (magnitude 7.0)	2035 Hayward Fault Earthquake (magnitude 7.0)	2035 Hayward Fault Earthquake (magnitude 7.0)
POLITICAL	U.S. Political System	Flawed Democracy	Healthy Democracy	Healthy Democracy
	U.S. Standing in the World	Declining Power	Multiple Superpowers	Preeminent Global Power
	U.S. Tax Rates	Lower Tax Rates	Higher Tax Rates	Similar to Today
	U.S. Tax Structure	Income Tax (Similar to Today)	Carbon Tax	Income Tax (Similar to Today)
	U.S. Spending Levels	Lower Expenditures	Higher Expenditures	Similar to Today
	U.S. Spending Distribution	Reduced Share for Metro Areas	Similar Share to Today	Larger Share for Metro Areas
	Immigration Policy	20,000 Annual Immigrants (to Bay Area)	80,000 Annual Immigrants (to Bay Area)	240,000 Annual Immigrants (to Bay Area)
	Trade Policy	10% Average Tariff Rate	3% Average Tariff Rate	0% Average Tariff Rate
	Environmental Policy	Reduced Regulations	Increased Regulations	Similar to Today
ECONOMY	U.S. Population Annual Growth Rate	+0.4%	+0.7%	+1.1%
	U.S. Jobs Annual Growth Rate	+0.5%	+0.4%	+1.1%
	U.S. Jobs Distribution	*Currently being refined*	*Currently being refined*	*Currently being refined*
	U.S. Productivity	+1.6%	+2.8%	+1.6%
LAND USE	Housing Preferences	Greater Preference for Urban Housing	Greater Preference for Urban Housing	Greater Preference for Dispersed Housing
	Workplace Preferences	Similar Preference to Today	Greater Preference for Dispersed Employment Centers	Greater Preference for Urban Employment Centers
	Telecommute Share	15%	30%	6%
	E-Commerce Market Share	20%	50%	50%
	Interregional Volumes	Limited Growth Rates	Current Growth Rates	Faster Growth Rates
TRANSPORTATION	Transportation Technologies	Autonomous Buses	High-Speed Rail, Autonomous Rail and Buses, Freight Aerial Drones	Hyperloop, Autonomous Rail and Buses, Freight Aerial Drones, Lower-Cost Helicopter Transport
	Autonomous Vehicle Market Share	10%	95%	75%
	Electric Vehicle Market Share	10%	95%	75%
	Sharing Preferences	Similar Preference to Today	Greater Preference	Reduced Preference
	Per-Mile Vehicle Operating Cost	$0.20 per Mile	$0.40 per Mile	$0.10 per Mile
	Annual Federal Transportation Funding (Bay Area)	$0.5 Billion	$2.5 Billion	$2.5 Billion

Photo - Karl Nielsen

Strategies – Consistent in Round 1 Analysis, But Different Across Round 2 Analysis

Plan Bay Area 2040 Strategies – Applied consistently across all Futures in Round 1

An important aspect of the first round of analysis of Horizon Futures Planning was the inclusion of the strategies from the Bay Area's most recently adopted long-range plan, Plan Bay Area 2040. The strategies were incorporated to understand how the currently adopted long-range plan would fare in an era of uncertainty. By including these strategies in the first round of analysis, staff could study how far these ideas move the Bay Area toward achieving the Horizon Guiding Principles and where the current plan's strategies fall short. This analysis helped to inform the conversation about which strategies to align with each Future. The Plan Bay Area 2040 strategies integrated in the first round of this analysis are marked in the first column of Table 3.

This package of strategies from Plan Bay Area 2040 did not mitigate the impacts of sea level rise and earthquakes, nor did it include any economic development strategies. Additionally, this list focused most transportation strategies on capital and operating investments rather than policy. The land use framework relied on focusing growth in the Plan Bay Area 2040 list of Priority Development Areas and applied the same urban growth boundaries as today.

Horizon Strategies – Applied slightly differently in low- and high-resource Futures in Round 2

Horizon generally built off the Plan Bay Area 2040 strategies – making minor adjustments based on Round 1 findings and outreach feedback – while incorporating dozens of new strategies across all four topic areas. The same strategies were studied in both Clean and Green and Back to the Future; however, because Rising Tides, Falling Fortunes had less robust regional growth as well as a significantly weaker economy than in the other two futures, only lower-cost strategies were able to be included in that Future.

Clean and Green and Back to the Future incorporated an expansive strategy package – eight from Plan Bay Area 2040 and 27 from Horizon. To support this package of strategies, a corresponding funding strategy was also needed to keep those Futures fiscally constrained. More than $200 billion in new revenue was assumed to be raised to support the strategies, and the impacts of such revenue generation were incorporated into the analysis.

Strategies integrated in the second round of Futures analysis for Horizon were largely developed through the companion Horizon Perspective Papers, as well as from other ongoing regional planning initiatives, such as The Committee to House the Bay Area (CASA), the Comprehensive Economic Development Strategy and the Adapting to Rising Tides (ART) program. In spring 2019, staff held a series of workshops focused on a set of 44 strategies, receiving input from the public on which strategies they felt addressed key challenges in each Future. The final set of strategies were chosen not only to test their individual contribution in improving outcomes in each Future, but also to study how a package of strategies may achieve synergies that yield outcomes greater than the sum of its parts.

Table 3. Plan Bay Area 2040 and Horizon strategies studied in Futures Round 2 analysis

		STRATEGY TITLE	Plan Bay Area 2040	RISING TIDES, FALLING FORTUNES	CLEAN AND GREEN	BACK TO THE FUTURE
ECONOMY	Improve Economic Mobility	Provide Portable Benefits for Part-Time and Freelance Workers				
		Create Incubator Program in Economically Challenged Communities				
		Provide Childcare Subsidy for Low-Income Households				
		Expand Construction Workforce Training Programs				
	Shift the Location of New Jobs	Implement Regional Office Development Impact Fees				
		Place Office Development Caps in Job-Rich Locations				
HOUSING	Spur More Housing Production	Assign Higher Allowable Densities in Priority Development Areas				
		Assign Higher Allowable Densities Around All Major Transit Stops				
		Assign Higher Allowable Densities in High Resource Areas				
		Streamline Development in All Areas Designated for Growth				
		Transform Aging Malls and Office Parks into Neighborhoods				
		Repurpose Public Land to Build Housing				
	Retain and Expand Affordable Units	Increase Renter Protections				
		Fund Affordable Housing Preservation and Production				
		Require 10% to 20% of New Housing to Be Affordable				
TRANSPORTATION	Improve Transit Reliability, Speed and Access	Operate and Maintain the Existing System				
		Build Express Lanes and Address Interchange Bottlenecks				
		Complete Set of Plan Bay Area 2040 Transit Expansion Projects				
		Build and Operate an Express Bus Rapid Transit Network				
		Build a New Transbay Rail Crossing				
		Modernize and Boost Frequencies to Create a Next Generation Rail Network				
		Extend the Regional Rail Network				
	Prioritize Active Modes	Provide Free Shared Bike, Scooter and Shuttle Services				
		Lower Speed Limits on Highways and Local Streets				
		Build a Complete Micromobility Network				
	Price Transportation Services	Develop a Single Platform to Access and Pay for all Mobility Options				
		Apply Tolls Based on Time of Day and Vehicle Occupancy on All Freeways				
		Provide Free Transit to Lower-Income Riders				
ENVIRONMENT	Adapt to Climate and Natural Disaster Impacts	Keep Urban Growth Boundaries in Place				
	Reduce Our Environmental Impact	Modernize Existing Buildings with Seismic, Wildfire, Drought and Energy Retrofits				
		Partially Adapt to Sea Level Rise				
		More Fully Adapt to Sea Level Rise				
		Adapt Highway 37 to Sea Level Rise				
		Purchase Disaster Recovery Financing to Speed Recovery				
NEW REVENUE		Raise Revenue with a Progressive Tax Package to Pay for Above Strategies	$0	$75 B	$225 B	$225 B

The analysis undertaken in both Rounds 1 and 2 uses a set of computer modeling tools, described in brief detail in the modeling sidebar and in greater detail in the Appendix. The results of the two analyses are presented throughout this document and are the preliminary basis for how ABAG and MTC staff have ranked the effectiveness of strategies. Note that Chapter 3 focuses on how the full package of strategies improves overall outcomes in the Bay Area, whereas Chapter 4 explores strategy findings one by one in order to make more specific recommendations.

MODELING

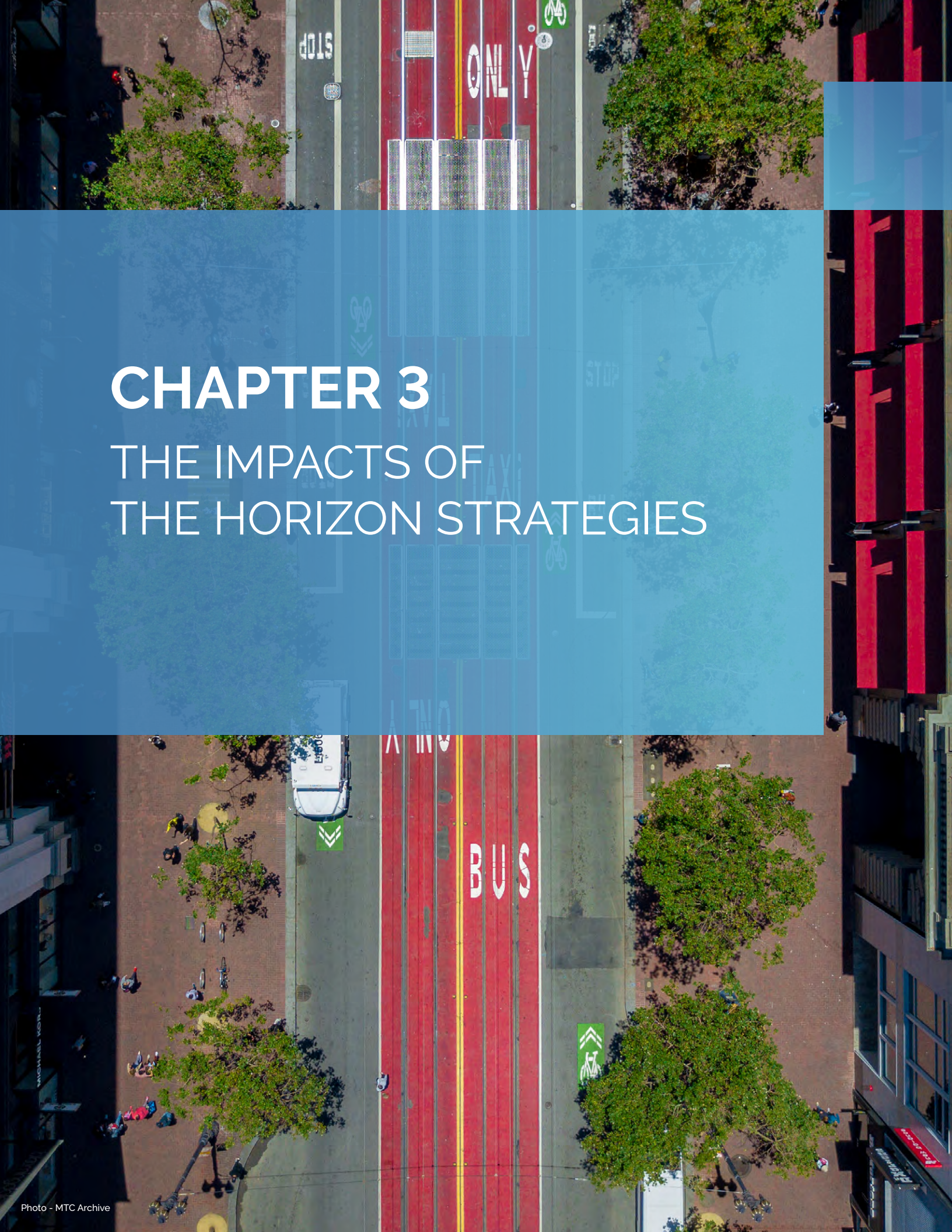
Futures Planning is based on findings from analytic results and the output of computer modeling tools. Horizon's analytical work built on the past work of Plan Bay Area and Plan Bay Area 2040, and used Futures Planning as an opportunity to build out new computer modeling functions. At the heart of MTC and ABAG's analysis are three analytic stages: a regional level economic and demographic analysis (REMI 2.10 and other tools), a land use model (UrbanSim 1.5), and a transportation model (Travel Model 1.5). The three analytic stages use data on the Bay Area's current conditions and add in assumptions about future conditions to project what the Bay Area would look like in future years should those conditions occur. These analytic stages work together, with key data outputs from one phase passing on as inputs into the next one. Some information flows through feedback loops, but generally data outputs flow from the economic and demographic analysis to the land use model to the travel model.

For the Futures Round 1 analysis, staff developed three distinct sets of 2050 forecasts, one for each Future. The 2050 forecasts were different in each Future based on the assumed external forces, which led to varying rates of economic and population growth as well as different development and transportation outcomes. For the Futures Round 2 analysis, staff again developed three distinct sets of data, one for each Future, and this time incorporated Horizon strategies packaged together. These results, when compared against the Round 1 analysis, helped answer the question of how a set of new policies might improve regional outcomes in a variety of possible future conditions.

In addition to these comprehensive analyses, staff also conducted special sensitivity analyses to explore the effect of individual Horizon strategies. Each time a special sensitivity analysis was done, the models were run for each of the three Futures. This more focused analysis allowed for a clearer understanding of the impact of an individual strategy. In Chapter 3, the findings used the comprehensive Future run, which incorporated all the strategies at once. The one exception was some of the findings in the Diverse section, which explored some of the sensitivity findings where an individual strategy was studied in isolation. In Chapter 4, the findings often use runs from the sensitivity analyses – this is especially true for the economy, housing and environment strategies. The parallel Project Performance effort, which explored project results against the same three Futures, helped to inform transportation strategy recommendations; when needed, transportation strategies beyond Project Performance were run individually as well. The technical notes in each strategy profile in Chapter 4 discuss which analysis was used to understand strategy effectiveness.

For more information on the three computer modeling tools – REMI, UrbanSim and the Travel Model – and the corresponding analysis process, please refer to the Appendix for additional information.

The Round 1 modeling results presented in the Futures Interim Report (released in March 2019) were re-run with the same assumptions but with improved modeling tools. Because of this adjustment, some of the Round 1 values presented in this report may be slightly different from the results in the Futures Interim Report.



CHAPTER 3

THE IMPACTS OF THE HORIZON STRATEGIES

Photo - MTC Archive

THE IMPACTS OF THE HORIZON STRATEGIES

The Futures Interim Report, released in March 2019, identified how different external forces beyond the Bay Area's control created both opportunities and challenges. For example, slow economic growth studied in Rising Tides, Falling Fortunes led to reduced demand on the Bay Area's overheated housing market but it also led to reduced revenues and stagnant wages for many residents. Similarly, a privately operated fleet of electric driverless vehicles in Clean and Green reduced transportation-related emissions, but it also triggered additional traffic congestion. The Futures Interim Report explored how the three Futures affected the Bay Area for better and worse, identifying opportunities to incorporate strategies to improve outcomes in each. This report examines how a suite of new strategies can move the Bay Area toward the vision of the Guiding Principles.

In the following section, new strategies' combined impacts are clustered under the five Horizon Guiding Principles to demonstrate how new strategies, when evaluated in tandem, affect regional goals. In some cases, the impact of the new strategies may be more or less effective in one Future compared to others, while other strategies might prove consistent across any Future. As such, the consistent impacts of new strategies across all the Futures are discussed first, with specific findings unique to each Future presented second. Graphics are included in each section to illustrate the analytical model outputs. Mapped data is presented across 34 sub-county areas known as Super Districts, which enable visualization of high-level trends at both the county and sub-county levels.

Photo - James Sullivan, unsplash.com

AFFORDABLE

Affordability in the Bay Area is closely linked to the high cost of housing. In 2015, one-third of Bay Area households were characterized as cost-burdened due to unaffordable housing, with the burden greater and more common for lower-income households. The forecasted cost of housing is determined based upon the Bay Area UrbanSim land use model by several factors, including the regional economy, demand for housing and the attributes of the units that are built, while average household income is derived from outputs of the Regional Economic Modeling, Inc. (REMI) model. The amount of housing and where it is built is largely driven by policies established by local governments, the region and the state – including zoning, fees and subsidies, streamlining, and growth boundaries.

In Futures Round 1 analysis, the location of future housing growth was driven in large part by Priority Development Areas (PDAs), the central element of the Regional Growth Framework in Plan Bay Area 2040. Paired with strategies to increase both development capacity and development profitability (to reflect streamlining and reduced parking minimums), the growth framework influenced the location of housing growth in each Future. In addition to these location-based strategies, modeling for Futures Round 1 assumed that 10% of new housing in communities with PDAs would be deed-restricted, another Plan Bay Area 2040 strategy. Unfortunately, the Plan Bay Area 2040 strategies were insufficient to blunt the rise of housing unaffordability in the three Futures through the year 2050. In addition to persistently unaffordable housing conditions projected in all three Futures, external forces combined with the Plan Bay Area 2040 strategies led to a continued jobs-housing imbalance in the Bay Area, with many job-rich communities seeing limited housing growth because they had nominated few or no PDAs.

To combat these challenges, Futures Round 2 studied an expanded suite of housing strategies and assumed changes in the zoned development capacity both around all major transit stops and in High Resource Areas with basic transit service levels. The strategies package also integrated a higher assumed level of inclusionary zoning in communities with strong residential markets and paired this with a strategy to generate $1.5 billion annually in new revenue for affordable housing. Lastly, public lands, aging office malls and aging office parks were identified as possible large catalyst sites that, if rezoned, might offer additional development capacity for the Bay Area. Large parcel sizes associated with these locations might offer greater levels of developer profitability that, if coupled with companion strategies, may enable greater levels of community benefit in the form of affordability, sustainability or resilience benefits.

Housing affordability challenges are not limited to the Bay Area's low-income households. Moderate-income earners also struggle with high housing costs. Measures that reduce the cost burden on moderate-income households were not directly studied through the Futures analysis. Given the difficulty in meeting the affordability needs of low-income residents, finding market-based policy solutions, without or with limited government subsidy, will be crucial to improve cost-burdened conditions for the Bay Area's moderate-income earners that also struggle with housing affordability. In Futures Round 2, an increased growth footprint that expanded beyond Priority Development Areas expanded the Bay Area's development capacity – a strategy that could help reduce the land costs that are significant drivers of high housing prices. In both rounds of analysis, staff continued to study the effects of streamlining development inside growth areas, which is another way to reduce development costs and in turn may reduce the housing cost burden on moderate-income households.

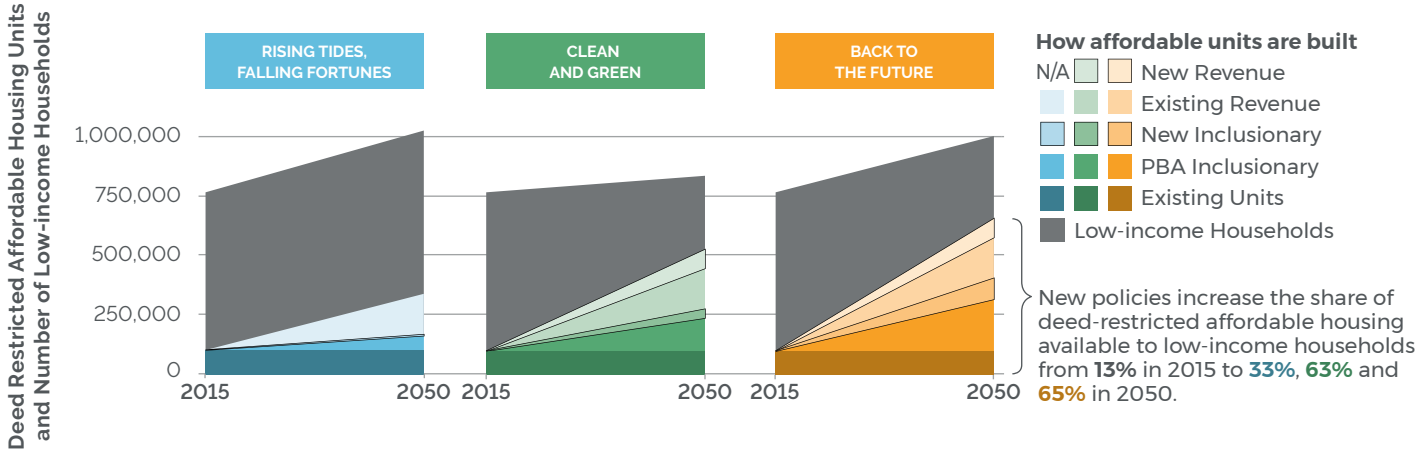
In short, the wide-ranging set of strategies integrated into Futures Round 2 led to a series of positive effects. The additional development capacity could provide meaningful relief for market-rate homebuyers, the complementary affordable housing strategies closed a significant portion of the housing need gap for low-income residents and the overall location of housing shifted slightly toward job-rich locations.

Affordable housing strategies, particularly in the higher-growth and higher-resource Futures, increased the deed-restricted affordable housing stock significantly.

Two Horizon strategies focused directly on increasing the Bay Area's supply of deed-restricted affordable housing, which is critical given that naturally occurring affordable housing may become increasingly rare in the future. Increasing the inclusionary zoning rate was included to ensure a greater percentage of market-rate development projects would be affordable for low-income residents and combined with increases in the amount of affordable housing revenue available to local governments to fund new deed-restricted developments. The inclusionary policy builds off the Plan Bay Area 2040 strategy, whereas increased revenues for affordable housing construction would supplement the roughly $3 billion the Bay Area currently has access to annually from existing federal, state and local programs.

Figure 1 illustrates the rate at which new deed-restricted affordable housing would be forecasted to develop in the Bay Area, with the number of low-income households as the backdrop. Given wide-ranging economic conditions and uncertainty in demographic projections, it is important to remember that the number of low-income households is not constant across the three Futures. These new strategies continue to address the Bay Area's affordable housing gap and would improve conditions markedly from today's deficit, but on their own, these strategies would not house all low-income households in deed-restricted affordable housing by 2050. However, they set the Bay Area on a much more positive trajectory in which the affordable housing gap for low-income households could be closed by end of century.

Figure 1. Effect of new policies on number of deed-restricted affordable housing units, 2015 to 2050



Strategies to expand housing development beyond the existing Priority Development Areas enabled many more homes to locate near transit, with a more limited effect on growth in High Resource Areas.

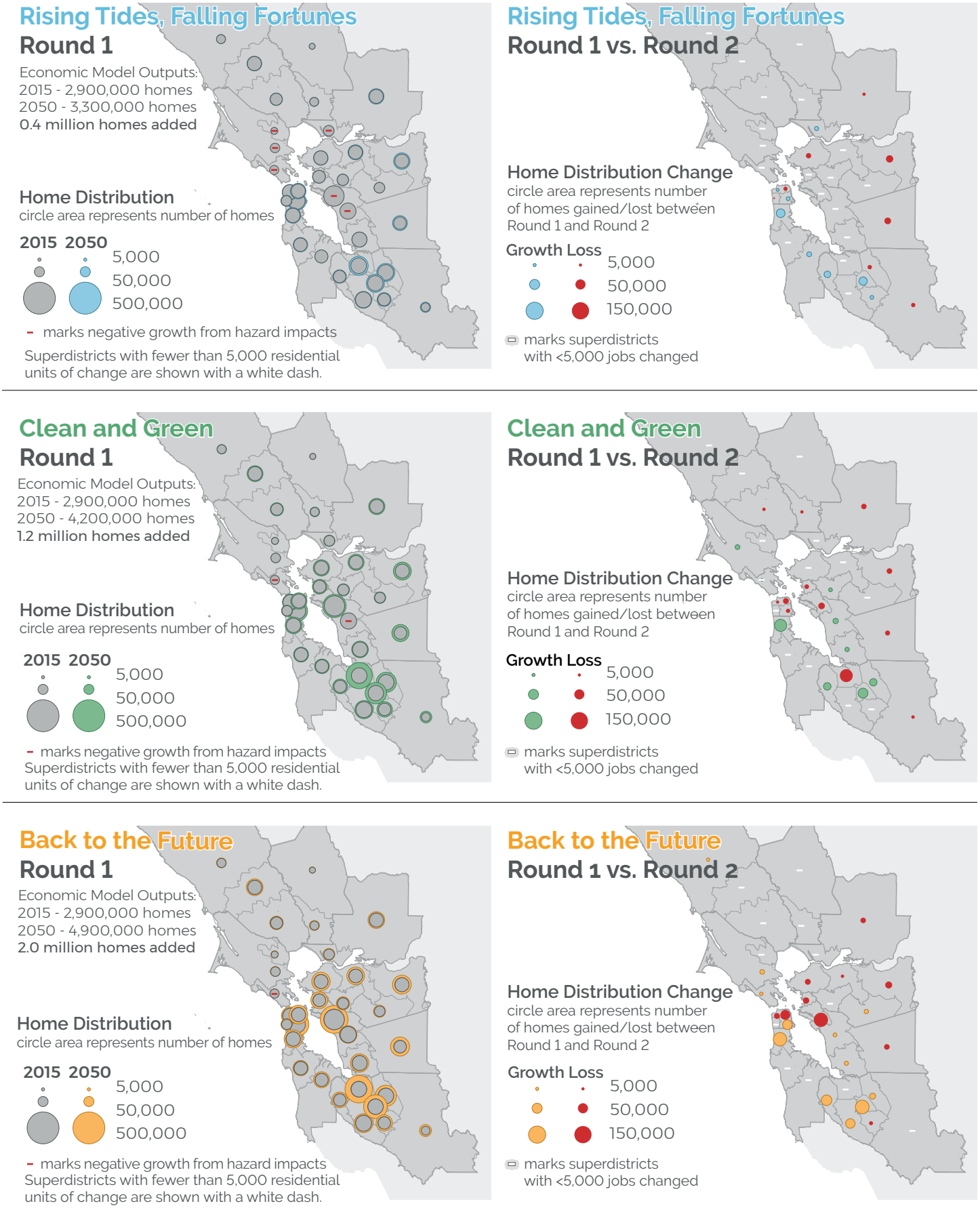
Plan Bay Area 2050, like prior iterations of Plan Bay Area, will distribute growth throughout the Bay Area. Housing growth will be based on strategies integrated in the plan, which traditionally have focused on encouraging nearly all such growth to cluster in locally nominated PDAs with moderate or high levels of transit access. While this strategy has been successful in encouraging a greater share of growth in these locations, Horizon analyses to date have shown that this approach has serious shortcomings. In addition to the overall quantity of housing production being far short of what is needed in the Bay Area, the PDA focus funnels most of the Bay Area's growth into lower-resource communities where displacement risk is often acute. Higher-resource communities with easy access to well-paying jobs, high-performing schools and the best environmental conditions have taken on a relatively small share of growth, which is a key equity concern in our increasingly inequitable region.

In Futures Round 2, the PDA-oriented growth pattern was modified to allow more growth around all major transit stops – not just those that were locally nominated as PDAs – and in all High Resource Areas with basic levels of transit service (areas within one-half mile of a bus stop with 30-minute peak-period frequency). Complementary streamlining provisions were expanded beyond PDAs to these new growth geographies as well. These changes led to more balanced housing growth in the Bay Area, with moderately higher housing growth in the West and South Bay (see Figure 2).

These changes were largely a reflection of the assumed development capacity increases associated with the Transit Rich Areas strategy in Futures Round 2. Figure 3 highlights the high percentage of growth that occurred in Transit Rich Areas and the relatively lower share of growth that occurred in the High Resource Areas. In Rising Tides, Falling Fortunes and in Clean and Green, the developable capacity near transit absorbed much of the growth before High Resource Areas with basic levels of transit service were developed. In Back to the Future, housing growth did increase a substantial amount in High Resource Areas with basic levels of transit service, but that Future had a very high overall growth rate providing intense development pressure. In short, increasing development capacity in priority areas studied in Futures Round 2 was successful in directing housing to Transit Rich Areas, both those that intersect with High Resource Areas and those that do not reflect that development capacity changes could be refined further to optimize for this outcome.

Photo - Martin Klimek

Figure 2. Distribution of housing growth in Round 1 and the change in distribution between Round 1 and Round 2 resulting from new strategies



ASSOCIATION OF BAY AREA GOVERNMENTS
METROPOLITAN TRANSPORTATION COMMISSION

Figure 3. Location of new housing units relative to growth geography, 2015 to 2050

CONNECTED

Connectivity is defined by Bay Area residents' ability to move around the region. Time spent commuting, congestion on the roadways, and the mode share between auto, transit, walking, bicycling and telecommuting are used to understand the Bay Area's connectivity. In the analysis, the unique external forces assumed in each Future, associated land use patterns and transportation investment strategies led to significant changes in how residents in 2050 would get around the Bay Area.

In Futures Round 1 analysis, the limited set of Plan Bay Area 2040 transportation strategies combined with external forces like earthquakes and sea level rise resulted in transit systems at overcapacity, significant traffic congestion and transportation systems not in service. In Clean and Green, an assumed increase in the cost to drive caused an increase in transit ridership demand which ultimately drove an increase in the share of transit commute trips. This increase in the share of transit trips, coupled with the 3 million new residents between 2015 and 2050, led the number of transit trips to more than double. The doubling of the number of transit trips ultimately caused most of the key transit systems to be well overcapacity, even with critical investments in transit like BART Core Capacity, which were included in Plan Bay Area 2040. In Back to the Future, the share of transit trips did not increase, but with nearly 6 million new residents, transit overcrowding and highway congestion became barriers to moving around the Bay Area. Assumed external forces in Back to the Future, like a low cost of driving and broad adoption of self-driving and mostly autonomous driving, resulted in over 200 million new vehicle miles traveled in the Bay Area. Finally, in the Futures Round 1 analysis, sea level rise impacts due to a lack of mitigation strategies in Plan Bay Area 2040 damaged portions of highway, further degrading the transportation system. The lack of mitigation strategies was felt most strongly in Rising Tides, Falling Fortunes, where 3 feet of sea level rise caused major highway closures across the nine-county Bay Area, and unfunded earthquake repairs from the assumed 2035 earthquake resulted in unrepaired, out-of-commission BART lines and highway segments in Alameda County.

In Futures Round 2 analysis, a set of 13 different strategies was studied to improve the connectivity challenges identified in the Round 1 analysis. The strategies aimed to shift mode share away from single-occupancy vehicles, decrease travel times, reduce congestion and transit overcrowding, and offer more equitable access to destinations regardless of one's income level. An expansive set of rail and express bus transit investments increased frequency and capacity on existing lines and extended services outward while also creating new connections between systems. On local streets, a set of new bike lanes coupled with vehicle speed reductions and access to free shared micromobility platforms was assumed in all growth areas and the nearby areas surrounding them. Finally, a set of pricing strategies was instituted to make it easier to access and pay for different transportation services, eliminate the cost of transit for lower-income residents, and price vehicles on the highway by occupancy and time of day.

Together this set of transportation-focused strategies resulted in fewer auto trips in all three Futures, but both travel times and vehicle miles traveled remained relatively unchanged. These changes were driven in

large part by the transportation investments described above, but also by the other changes to the Bay Area as part of the Round 2 analysis. The land use changes that occurred in Round 2, as well as the adaptation measures that protected key highway segments, also influenced the regional level transportation trends. The large set of investments and new policies resulted in some improved outcomes but also left some challenges unresolved.

Shifting residents' travel behavior away from driving and toward other methods remains a key challenge, although opportunities exist through micromobility investments.

Horizon analysis reinforced the difficulty in changing the travel methods residents use to move around the Bay Area. Since 1970, the share of Bay Area residents commuting by automobile has fluctuated between 75% and 81%[1]. In the Futures Round 1 analysis, the Clean and Green Future assumed a doubling in the per-mile cost to operate a vehicle in the year 2050 compared to conditions today, due to high taxes and regulations in this particular what-if scenario. This external force assumption was largely responsible for the modeled shift from automobile to transit commute trips, with the rate of all trips on transit rising from 6% to 10% in the Futures Round 1 analysis. In this example, external conditions were the primary driver of improved outcomes for modal shift, but in the Futures Round 2 analysis, new transit investments combined with a robust highway pricing strategy were used to encourage drivers to limit solo driving trips and opt for other modes. Horizon reinforced past MTC analysis which has shown that pricing, whether it is controlled by policy or a function of external forces like fuel prices, influences mode choice. At the same time, pricing strategies must be advanced in a thoughtful manner that more significantly integrates equity.

Another cause of significant mode shift in Horizon Futures Round 2 was a transformative set of investments in micromobility ranging from bicycles to e-scooters. In Round 2, these investments led to a significant rise in the share of walking and bicycling commute trips made, a finding that was based upon peer-reviewed academic literature. Interestingly, these shifts were much more significant than those for public transit and were possible with significantly less in funding. Figure 4 highlights these strategies as the major driver of mode share shift between the first and second round of Futures analysis.

Finally, one of the largest mode share shifts (for commute trips only) was not based on policy but rather due to external force assumptions about new technologies enabling higher levels of telecommuting. This external force was customized for each Future based on assumed technological shifts held constant for both Round 1 and Round 2 analyses. Horizon explored one future where telecommuting rates only marginally increased above current ones (Back to the Future) and another where telecommute technologies and company cultures enabled a third of Bay Area workers the ability to work from home (Clean and Green). Continuing to track the culture of telecommuting and flexible work schedules will help the Bay Area better understand how peak-period commute strains on the transportation system will change in the future.

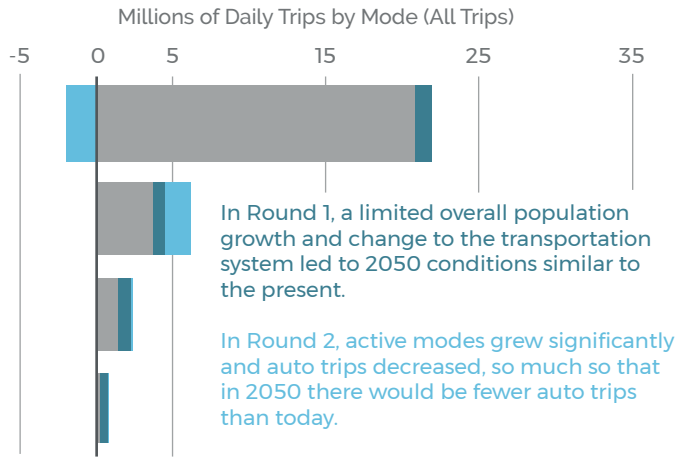
Photo - Bay Wheels

Figure 4. Mode share (table) and total number of trips by mode (graph) for all daily trips

This chart explores the mode of all trips. In other figures in this document, other variations of mode share are used. Commute trips, which represent roughly 15% of all trips, are sometimes used because commute volumes are often the biggest stressor on the transportation system. Also, short trips, or those that are less than 3 miles, are used to describe trips that may be more likely replaced by active modes.

Rising Tides, Falling Fortunes

Mode	2015	Round 1 2050	Round 2 2050
Auto	79%	74% ↓	68% ↓↓
Active	14%	15% ↑	21% ↑↑
Transit	6%	8% ↑	8%
Telecommute	1%	3% ↑	3%

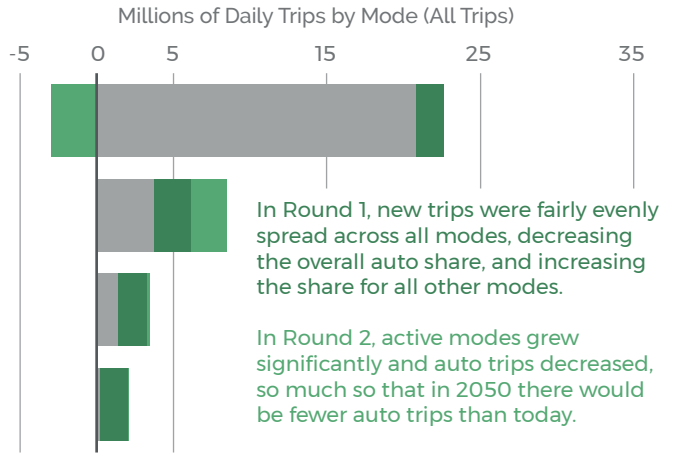


In Round 1, a limited overall population growth and change to the transportation system led to 2050 conditions similar to the present.

In Round 2, active modes grew significantly and auto trips decreased, so much so that in 2050 there would be fewer auto trips than today.

Clean and Green

Mode	2015	Round 1 2050	Round 2 2050
Auto	79%	66% ↓↓↓	58% ↓↓
Active	14%	18% ↑	25% ↑↑
Transit	6%	10% ↑	10%
Telecommute	1%	6% ↑	6%



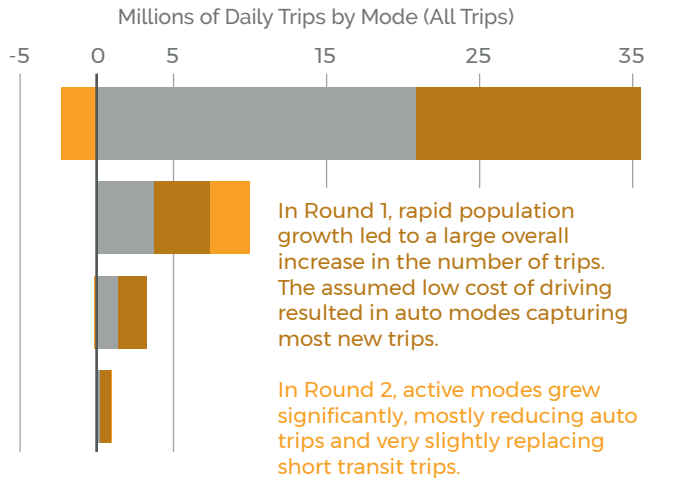
In Round 1, new trips were fairly evenly spread across all modes, decreasing the overall auto share, and increasing the share for all other modes.

In Round 2, active modes grew significantly and auto trips decreased, so much so that in 2050 there would be fewer auto trips than today.

Back to the Future

Mode	2015	Round 1 2050	Round 2 2050
Auto	79%	75% ↓	70% ↓
Active	14%	16% ↑	21% ↑
Transit	6%	7% ↑	7%
Telecommute	1%	2% ↑	2%

▲ **Magnitude of increase or decrease in modal share – longer and more arrows means a greater difference from baseline.**



In Round 1, rapid population growth led to a large overall increase in the number of trips. The assumed low cost of driving resulted in auto modes capturing most new trips.

In Round 2, active modes grew significantly, mostly reducing auto trips and very slightly replacing short transit trips.

Photo - Kingmond Young

Transit crowding challenges were alleviated in Futures Round 2, but some transit lines would need further action.

Already today the busiest routes during peak-periods are overcrowded with people unable to board trains and buses. In 2050 this issue worsened in the Futures Round 1 analysis in which more transit trips were made. To address this overcrowding challenge in Clean and Green and Back to the Future, over $100 billion in new transit capital investments and increased transit service levels led to significant reductions in transit crowding on many of the Bay Area's busiest corridors.

Despite these investments, a significant number of other lines continued to have transit crowding challenges. At times the more frequent service that accompanied the strategies increased transit's attractiveness and drove greater ridership, which in turn led to more transit crowding. This was the case for BART in the Clean and Green Future, where transit crowding was only slightly alleviated in part because there were an additional 100,000 new riders daily. In other cases, the transit crowding improvements are a reflection of both increases in service and reduced ridership between Round 1 and Round 2. This was the case for AC Transit, which had many trips replaced by the new Regional Express Bus system, new BART lines and likely some ridership loss as active modes took on a greater share of very short trips. Finally, unique circumstances, namely light rail modernization investments that doubled train frequency by splitting two-car trains into one-car trains, led to increased overcrowding on VTA. The frequency increase, as well as new land use growth associated with the Futures Round 2 growth framework, resulted in the system seeing large increases in ridership. But with only the same number of train cars to provide service, transit crowding worsened.

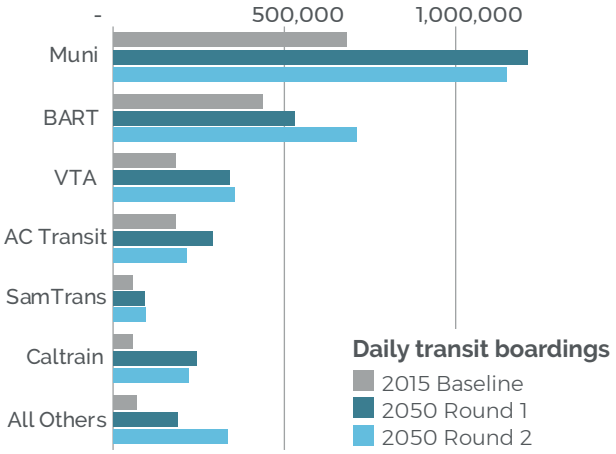
In Futures Round 2, the effect of short trips also lessened travel demands on transit systems, suggesting that riders who previously chose transit to complete short trips may convert to active modes if those methods are safer, more accessible and slightly faster. A key example of this shift from transit to active modes in Futures Round 2 was on the Muni system, where transit trips often cover shorter distances than other major transit operators and where bus speeds are among the lowest in the Bay Area. As shown in Figure 5, Muni saw a larger shift in boardings as compared to other transportation systems between Round 1 and Round 2. The new BART stations in San Francisco built as part of the second transbay crossing also influenced this shift in Muni boardings given that the BART line provides a faster alternative to some existing Muni bus and light rail lines.

The Futures Round 2 analysis highlighted a number of key transit trends, and the companion project performance analysis provided an opportunity to see in detail how projects perform. The benefit of the Futures analysis is the uncovering of the positive and negative synergistic effects of transportation projects. As new investments are made, the Bay Area will need to consider how co-located resources or alternate available modes might be positively or negatively affected and will need to partner to develop a more connected transportation system. Some systems, particularly those with large capacity-increasing investments, see an increase in transit ridership between the first and second round of Futures analysis, but there was not a truly significant shift in overall transit ridership, a disappointing result with such large investments.

Figure 5. Change in daily transit boardings (graph) and crowding (table)

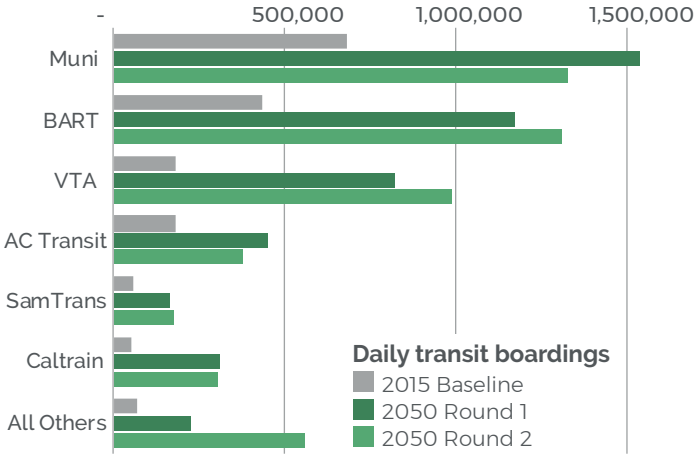
This chart explores both the overall transit ridership as well as the degree of crowding for transit riders. In the first round of Futures, many systems experienced large ridership growth, but had a corresponding increase in transit crowding. Strategies that increased frequency and capacity of transit systems in Round 2 often led to reductions in transit crowding (Note Rising Tides, Falling Fortunes had fewer investments). In the crowding column, negative values are good trends, especially when they also occur alongside increased ridership.

Rising Tides, Falling Fortunes



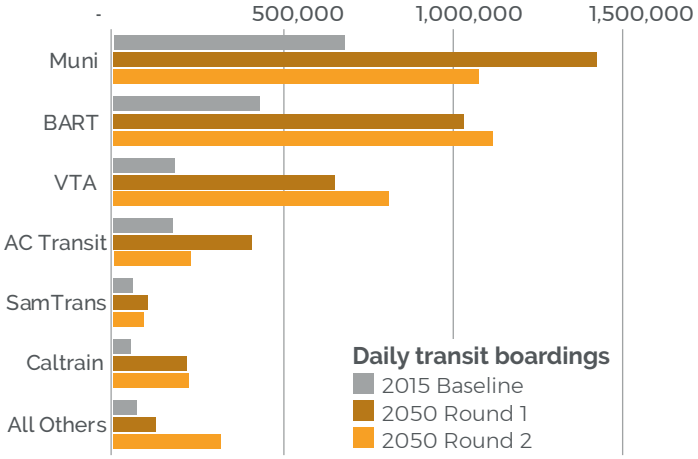
Transit Operator	Change in Ridership Rd 1 to Rd 2	Change in Crowding Rd 1 to Rd 2
Muni	-5%	-25%
BART	35%	-10%
VTA	5%	**+50%** ⚠
AC Transit	-25%	-100%
SamTrans	10%	0%
Caltrain	-10%	-60%
All Others	80%	-60%

Clean and Green



Transit Operator	Change in Ridership Rd 1 to Rd 2	Change in Crowding Rd 1 to Rd 2
Muni	-15%	-35%
BART	10%	-20%
VTA	20%	**+35%** ⚠
AC Transit	-15%	-65%
SamTrans	10%	-40%
Caltrain	0%	-15%
All Others	145%	-10%

Back to the Future



Transit Operator	Change in Ridership Rd 1 to Rd 2	Change in Crowding Rd 1 to Rd 2
Muni	-25%	-50%
BART	10%	-60%
VTA	25%	**+10%** ⚠
AC Transit	-45%	-100%
SamTrans	-10%	-35%
Caltrain	0%	-65%
All Others	150%	-55%

Traffic congestion declines slightly with investments to maintain the existing system and new pricing measures.

In the Futures Round 1 analysis, millions more daily vehicle miles traveled (VMT) led to gridlock on the Bay Area's roads, including extra miles from zero-occupant autonomous vehicles (see VMT changes in Figure 7). Congestion from increased overall VMT was made worse by unmitigated impacts from sea level rise. In Rising Tides, Falling Fortunes, unrepaired earthquake damage reduced the connectivity of the Bay Area's highway network.

In the Futures Round 2 analysis, a suite of factors led to reductions in highway congestion (see Figure 6). Investments in non-automobile modes reduced the share of vehicle trips in all three Futures (see Figure 4). A time-based and occupancy-based toll on highways further reduced pressure on regional highways during peak-periods, and complementary speed limit reductions on arterials reduced the risk of diversion to arterials. Finally, investment in sea level rise adaptation and recovery financing tools resulted in significantly fewer highway and transit closures due to hazards through the year 2050.

Together these strategies reduced highway congestion substantially in Rising Tides, Falling Fortunes and Clean and Green. In Back to the Future, much of the highway system remained congested in Futures Round 2. The toll on the Bay Area's highways may not have been as effective in Back to the Future because the assumed starting price to operate a vehicle 1 mile in that future was half of today's cost, and most drivers had autonomous vehicles available. Even raising the toll by 15 cents per mile only raised the cost of driving to slightly above the per mile driving costs as they stand in 2019. In any Future, truly dynamic pricing would be one way to more effectively use pricing to propel outcomes. In addition to having limited success in Back to the Future, the highway toll raises equity concerns, with tolls affecting lower-income households the most. A means-based fare on transit may be one direct way to counter the equity downsides of tolling.

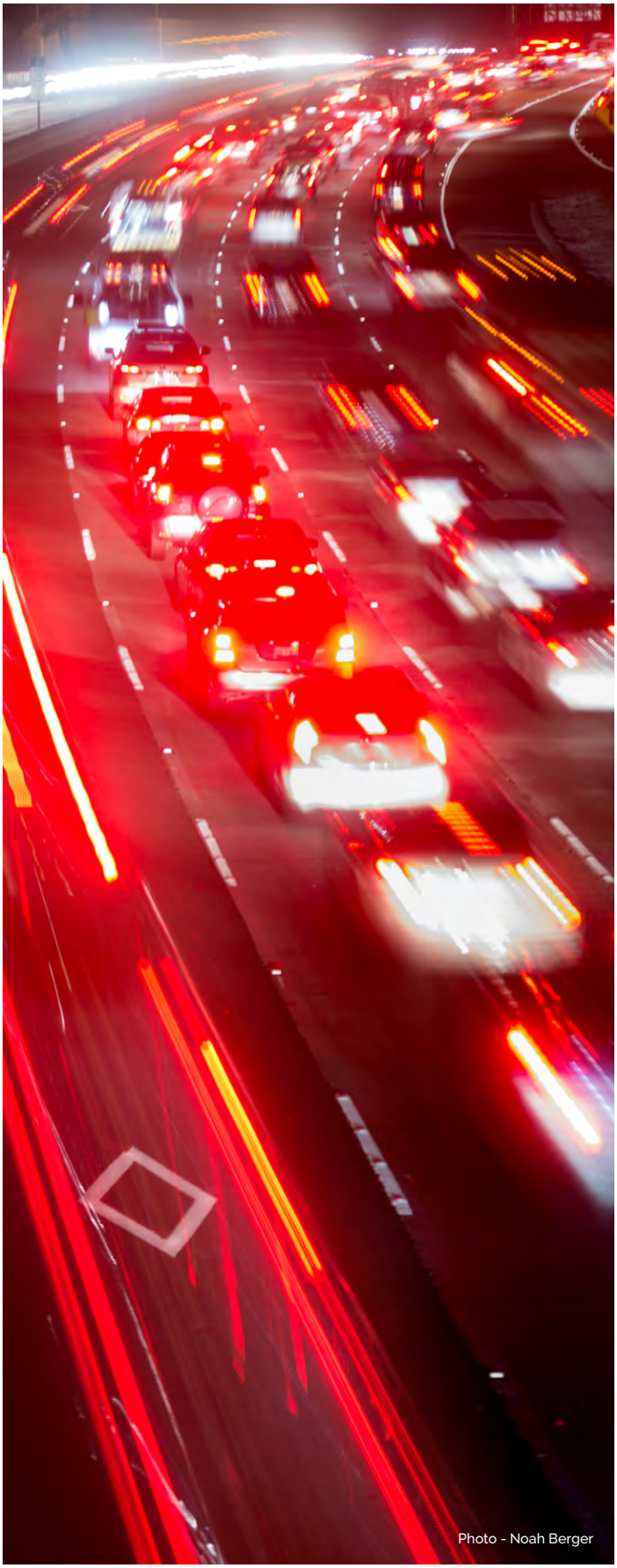
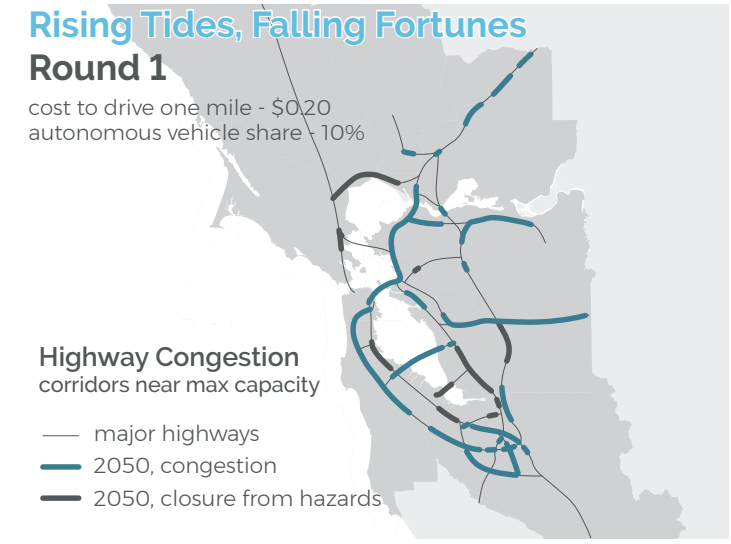
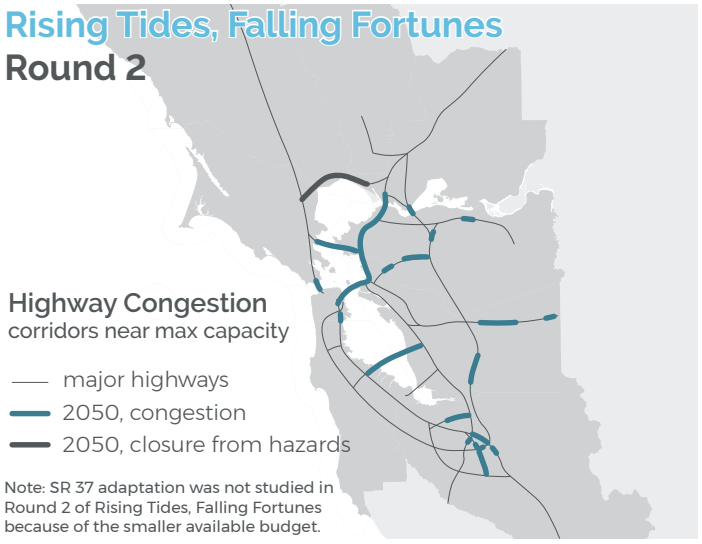
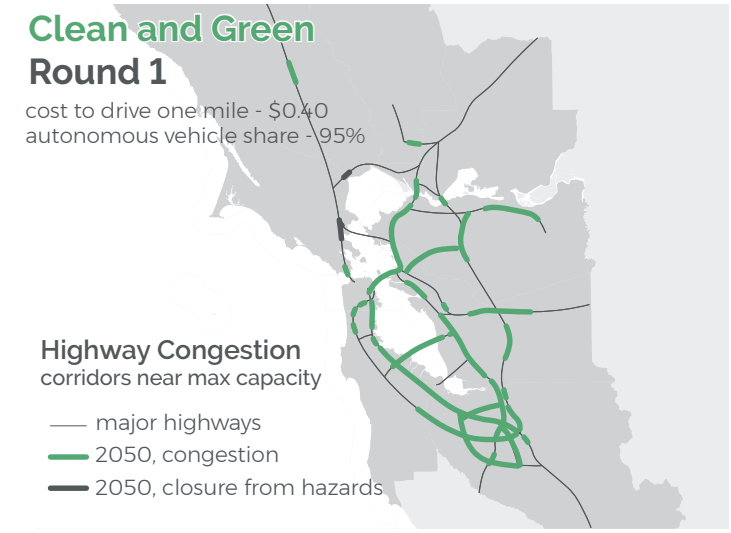


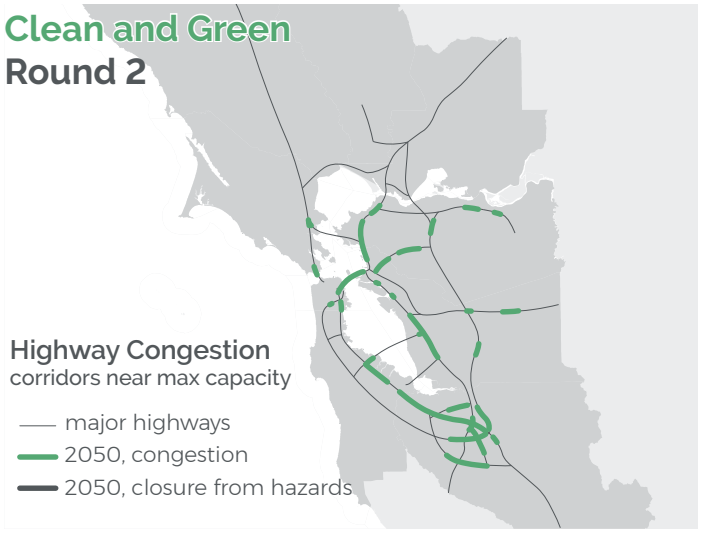
Photo - Noah Berger

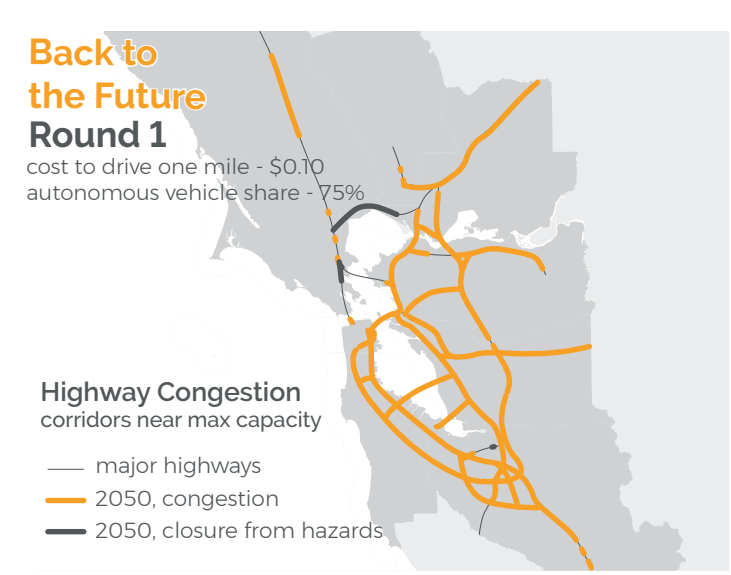
Figure 6. Congestion and closures on major highways in Round 1 and Round 2 analysis







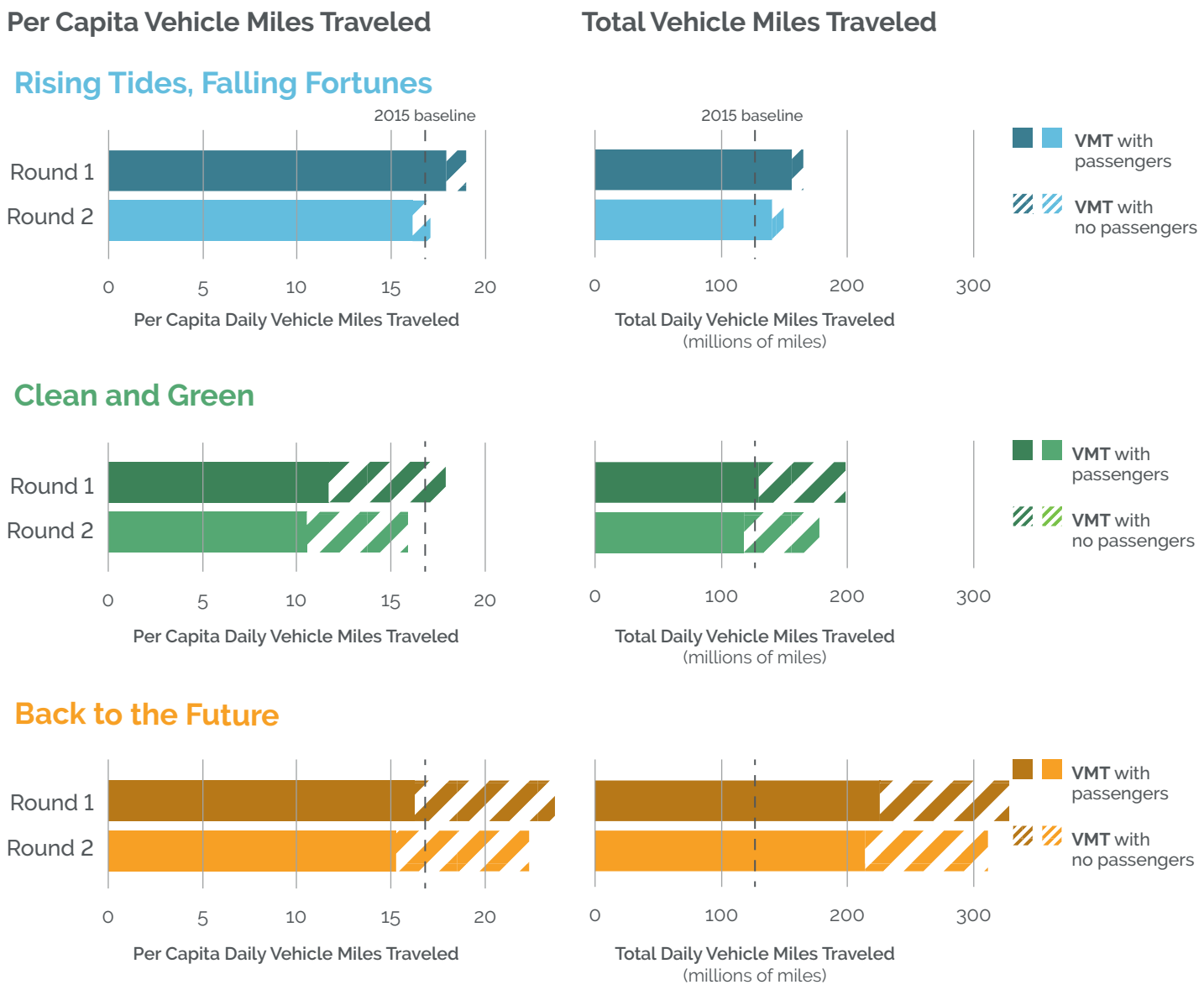




The reduced number of auto trips resulted in a 10% decrease in VMT in Rising Tides, Falling Fortunes and Clean and Green. In Round 2 of Clean and Green, the total VMT with passengers in 2050 dropped below 2015 levels despite 3 million new residents, an impressive result to imagine. However, in a future with widespread autonomous vehicle adoption, those significant gains in traditional travel were wiped away by 60 million daily miles traveled by zero passenger vehicles. In Back to the Future, the number of auto trips decreased, and VMT decreased by 5%. The milder reduction in VMT in Back to the Future could be a result of adaptation measures offering new highway options and highway tolling being less effective (as described previously) as well as possibly higher levels of housing and job growth in areas with higher levels of associated VMT. Five percent and 10% reductions in VMT as a result of the strategies studied in Round 2 are important trends to note as Horizon pivots to the Plan Bay Area 2050 Blueprint phase, given that reducing VMT is central to achieving Plan Bay Area 2050's requirements and land use and transportation goals.

Photo - Noah Berger

Figure 7. Per capita and total vehicle miles traveled (VMT)



DIVERSE

For Horizon's purposes, race, age and income are the factors that are used to describe the Bay Area's diversity into the future. The Bay Area's composition in each Future is driven primarily by external force assumptions on the rate of immigration as well as birth and life expectancy rates unique to each Future. While immigration to the Bay Area from abroad varies widely from 20,000 annually (roughly one-quarter of today's level) in Rising Tides, Falling Fortunes to 240,000 annually (roughly three times higher than today's level) in Back to the Future, one trend of the past three decades continues in all Futures: most immigrants originate from Latin America and Asia.

The Bay Area also is striving to maintain the rich culture of communities that are here today and expand upward mobility opportunities to all Bay Area residents. In recent years, displacement risk has spread from the Bay Area's core to all nine counties as rents have skyrocketed. Using a methodology that flags neighborhoods with decreasing numbers of lower-income households, the share of lower-income residents at risk of displacement has been projected in each Future. Reducing displacement risk would help to ensure that households and communities of all income levels are able to continue to call the Bay Area home. In addition to maintaining stable neighborhoods, increasing the inclusivity and access to opportunity in all neighborhoods can help support the diversity and equity Guiding Principle goals.

In Futures Round 1, these external forces resulted in divergent population projections and regional prosperity. In Rising Tides, Falling Fortunes, assumptions about a weak global economy and restrained national levels of immigration led to minimal population growth in the Bay Area. In Clean and Green, a future with similar levels of immigration to today and a strong national economy, the Bay Area's population grew at a pace similar to past decades and continued the trend of adding many new higher-income earners. In Back to the Future, an assumed increase in international immigration to the United States as a whole and a strong global economy led to large growth; the Bay Area overall became more prosperous but added many people from all incomes. Two trends played out in all three of the Futures in Round 1: the Bay Area became more racially diverse and added over 1 million new seniors above today's level, reflecting an aging population and longer life expectancy. These are trends the Bay Area should expect with reasonable certainty.

The stronger economies in Back to the Future and Clean and Green had many positive effects, but one downside was continued displacement pressure in many Bay Area communities. Displacement pressure in Rising Tides, Falling Fortunes was also present in 2050, but was half that of Back to the Future and nearly a third as expansive as in Clean and Green.

In the Futures Round 2 analysis, population and job growth rates, income levels, and racial composition of the Bay Area's residents remained nearly identical to Round 1. For this reason, in Futures Round 2 the analysis focused more closely on displacement risk, as well as the relative effectiveness of different strategies on reducing displacement risk. There are many policies that Bay Area communities are exploring to address displacement risk today. The Horizon initiative is different, in that it is looking out over 30 years to understand possible long-range strategies to tackle this risk. In the Futures analysis, anti-displacement strategies such as renter protections slowed the rate of change, but they did not change the underlying conditions and thus proved ineffective in reducing displacement over a 30-year period. Larger, more expansive strategies focused on delivering deed-restricted affordable housing did appear to have a slightly positive effect in reducing displacement.

Just as the Futures Round 2 analysis demonstrated marginal changes in displacement risk, relatively limited gains were made in increasing lower-income households' access to opportunity. By using High Resource Areas as a component of the growth framework, the Round 2 results showed a slight increase in the share of lower-income households living in High Resource Areas. Building off the findings described in the affordability section, to achieve a more inclusive Bay Area, the strategies intended to prioritize affordable housing growth in High Resource Areas will need to be strengthened beyond what was studied in Horizon.

By expanding the growth framework to include all High Resource Areas and increasing inclusionary zoning requirements, a slightly greater share of lower-income households locate in high-resource communities.

As shown in Table 1 the share of lower-income households in High Resource Areas increased slightly by the year 2050 in Clean and Green and Back to the Future compared to Round 1 results. Two strategies included in Futures Round 2 are responsible for this increase: enlarging the development capacity of often-exclusionary High Resource Areas and the expansion of inclusionary zoning. The increase in lower-income households is most noticeable in Back to the Future where overall there was a higher level of housing growth in the High Resource Areas with basic transit service.

But the findings still show a smaller share of lower-income households living in High Resource Areas in 2050 than today. To further advance lower-income households' access to opportunity, other strategies could be implemented that more directly focus affordable housing in High Resource Areas. The affordable housing revenues studied in Futures Round 2 were not specifically directed to High Resource Areas, but they could be, which would likely further advance lower-income households' access to High Resource Areas. Additionally, as outlined in Chapter 4, there is discussion of how to increase the share of growth in High Resource Areas through zoning changes. In particular, developing appropriate solutions to spur a greater share of housing growth in places with basic transit service will be key to increasing the economic diversity across the Bay Area.

Table 4. Distribution of lower-income households in Low and High Resource Areas

	2015	2050					
		RISING TIDES, FALLING FORTUNES		CLEAN AND GREEN		BACK TO THE FUTURE	
		Round 1	Round 2	Round 1	Round 2	Round 1	Round 2
Low Resource Areas	64%	64%	65%	67%	66%	69%	67%
High Resource Areas	36%	36%	35%	33%	34%	31%	33%

WORSENING trend between Round 1 and Round 2; 24,000 fewer lower-income households live in High Resource Areas.
IMPROVING trend between Round 1 and Round 2; 36,000 more lower-income households live in High Resource Areas.
IMPROVING trend between Round 1 and Round 2; 66,000 more lower-income households live in High Resource Areas.

Displacement risk remained largely unchanged between Futures Round 1 and Round 2, with permanently affordable units appearing to be the best long-term solution to reduce displacement risk.

Displacement of lower-income residents and communities of color is a trend that has worsened significantly in the Bay Area over the past decade. In Futures Round 1, displacement risk was calculated by measuring the number of lower-income households that decreased in a neighborhood in future years. Clean and Green showed the greatest displacement pressure of the three Futures explored, largely due to widening income inequality. To address this challenge, staff explored a set of rental protections as well as two strategies to increase the share of deed-restricted affordable housing. The rental protections were shown to have greater benefits in the first 5 to 10 years, but by 2050 such strategies had a limited effect on driving down the Bay Area's displacement risk.


Photo - Karl Nielsen

In the second round of analysis, which included the full set of housing strategies, displacement risk was relatively unchanged, with a slightly greater share of lower-income households at risk of displacement in Rising Tides, Falling Fortunes and Clean and Green (see Figure 8). Displacement risk is typically calculated as an "either/or" state but also can be characterized by communities that are changing more or less. Figure 8 illustrates some good news as a result of the strategies, showing a decreasing severity of displacement, particularly for the neighborhoods that in Round 1 had the most significant change. Staff believe the severity of displacement risk changed because there may have been a larger baseline of affordable units for lower-income households. When taking a 30-year period perspective to displacement, staff understand deed-restricted units that ensure lower-income households always have a place within a community to be a strong long-term strategy for reducing displacement in the Bay Area. However, as seen in the Affordable section, increasing the number of deed-restricted units via a package of different strategies is an uphill climb for the Bay Area and one that comes with a hefty price tag.

Figure 8. Overall and severity of displacement risk

Overall Displacement Risk

Displacement risk is a measurement of neighborhoods where the number of lower-income households is shrinking. Lower-income households include both low- and middle-low income quantiles.

Rising Tides, Falling Fortunes

In Round 1,
24%
of lower-income households were at risk of displacement.

In Round 2,
25%
of lower-income households were at risk of displacement.

Clean and Green

In Round 1,
46%
of lower-income households were at risk of displacement.

In Round 2,
47%
of lower-income households were at risk of displacement.

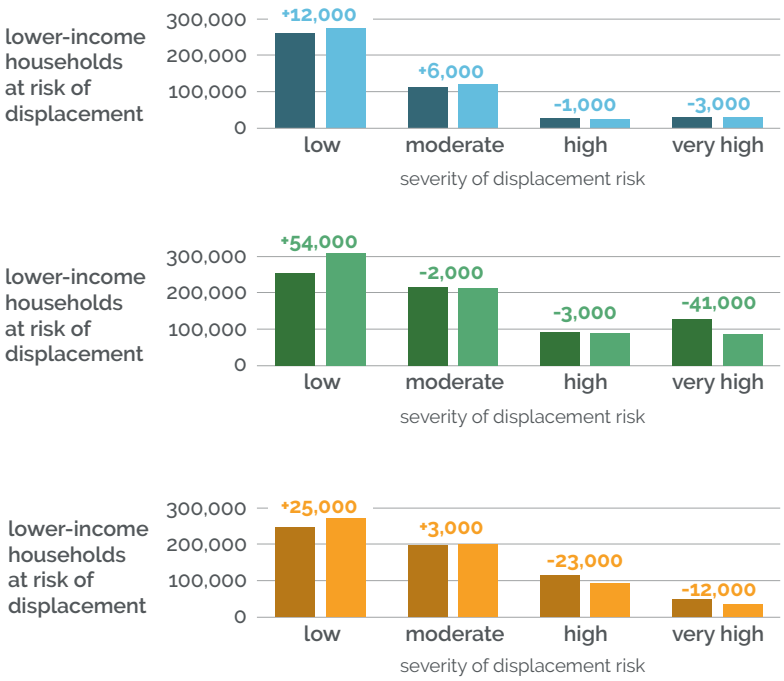
Back to the Future

In Round 1,
33%
of lower-income households were at risk of displacement.

In Round 2,
32%
of lower-income households were at risk of displacement.

Severity of Displacement Risk

Of the lower-income households at risk of displacement, some are in communities changing faster than others. The chart illustrates that despite at times increasing overall displacement risk, severity was lessened in all Futures.



HEALTHY

The Bay Area's environmental health is defined by both the region's progress in reducing impacts on the environment, and its ability to adapt to and mitigate the impact of hazards. Under the Horizon initiative, two primary ways the Bay Area aims to reduce human impact on the environment are to reduce greenhouse gas emissions and limit development on existing greenfield and agricultural lands. For each Future, the per-capita greenhouse gas emissions from transportation sources and the annual rate of greenfield development were forecasted. Additionally, two hazards, sea level rise and earthquakes, were applied to the Futures as external forces. Sea level rise, a slow onset force with impacts at specific locations, is applied at varying rates in each Future depending on global and national climate policies. A magnitude 7.0 earthquake on the Hayward Fault in the East Bay was used to study the severe localized damage that a single seismic event can have and the recovery challenges afterward. A range of impacts from the hazards is studied to generally understand how the Bay Area can prepare for, respond to and recover from any shock the region might face – whether it is a flood, earthquake or fire.

The Futures Round 1 analysis assumed sea level rise and seismic impacts would go unmitigated through the year 2050, given that Plan Bay Area 2040 did not include any strategies to address these external forces. Since the start of the Horizon process, many cities have already started to take the lead on both issues. Oakland passed a soft-story ordinance requiring 20,000 multifamily units be seismically strengthened before 2025, joining Alameda, Berkeley, Fremont and San Francisco, whereas Hayward took a first step to require owners of fragile buildings to evaluate their structure. On the sea level rise front, many planning efforts have taken hold and are advancing toward actionable shoreline adaptation strategies, with Foster City and San Francisco each passing large local funding measures to jump-start their resilience work.

Photo - Karl Nielsen

In Futures Round 2, a package of resilience strategies was studied to measure their collective impact. For sea level rise, regional adaptation strategies were assumed to be funded and constructed prior to inundation. For residential seismic safety, an existing building retrofit program was assumed to be implemented to reduce the likelihood of damage to older buildings in a future earthquake. Together these measures significantly reduced the impact of damage to housing as illustrated in Figure 9. The sea level rise strategies also mitigated flooding impacts for tens of thousands of jobs on the shoreline and protected critical portions of low-lying transportation infrastructure.

Resilience strategies can drastically lessen the climate and hazard impacts to the Bay Area's housing, transportation, environmental and economic systems.

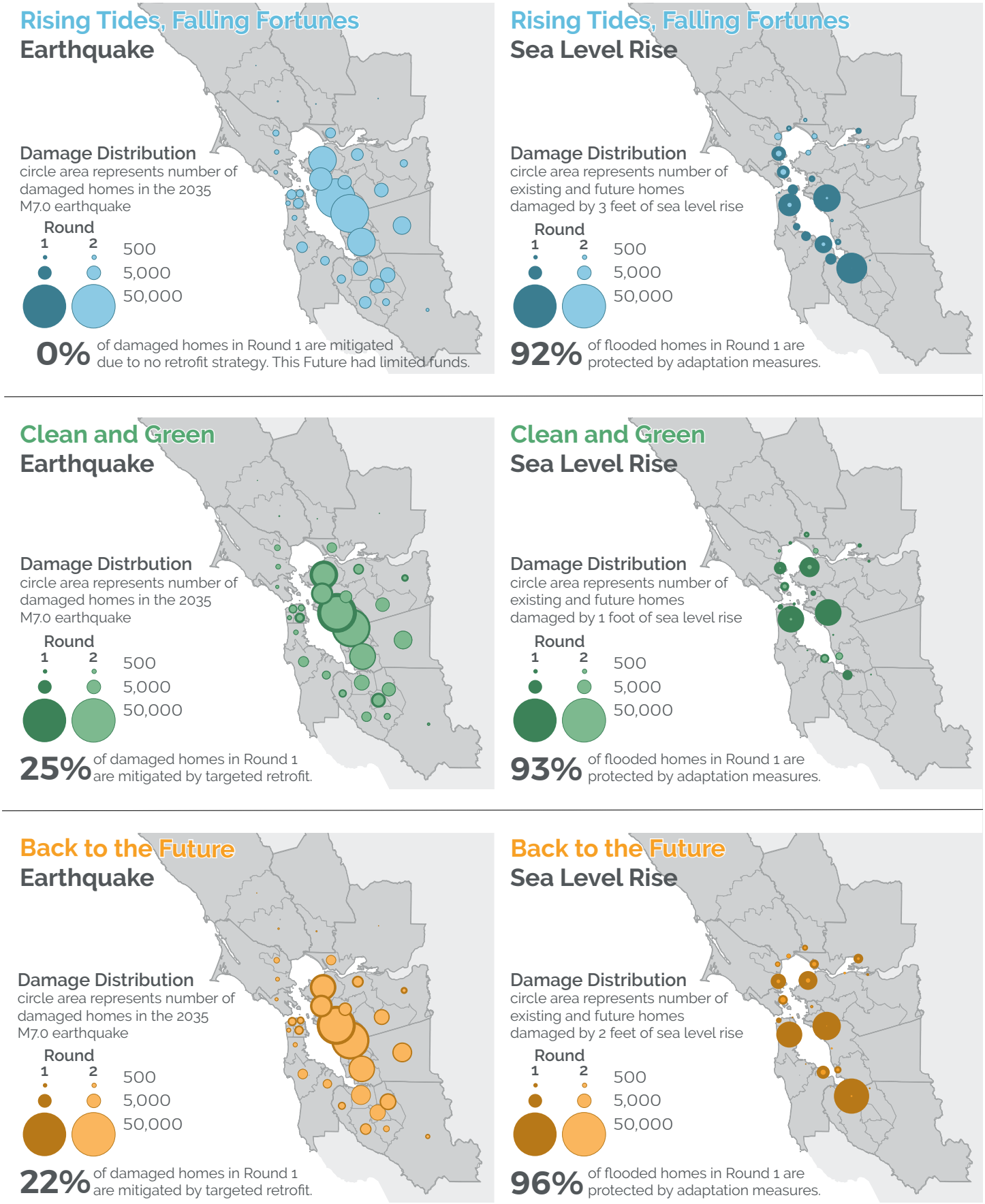
In Futures Round 1, the Bay Area lost huge portions of the housing stock to sea level rise due to a lack of mitigations. In addition to existing homes in low-lying areas, tens of thousands of housing units constructed within Priority Development Areas early in the planning period were flooded only decades later. In Futures Round 2, both existing residential structures as well as new development primarily located in PDAs were protected by shoreline adaptation measures. Because many residential communities are also co-located with job centers and transportation infrastructure, these adaptation measures offer multisector benefits.

In Futures Round 1 analysis, the Plan Bay Area 2040 urban growth boundary strategy continued to limit urbanized development on greenfield lands. However, the Bay Area has a new risk of losing natural lands – this time from unmitigated climate change impacts. Leveraging other open space and sea level rise analysis of the Bay Area, the number of acres of natural lands flooded by 1, 2, and 3 feet of sea level rise vastly outpaced impacts from new urbanized development (see Figure 10).

In Futures Round 2, the urban growth boundary strategy remained in place, effectively resulting in negligible regional changes in the amount of greenfield land developed between Futures Round 1 and Round 2. On the other hand, the full package of adaptation strategies studied in Clean and Green and Back to the Future led to massive increases in the amount of natural ecosystems that were protected from sea level rise. While unstudied as part of Futures, a similar scale of investment and adaptation may be needed to ensure the Bay Area's forests and rangelands also adapt to changing conditions in ways that improve ecosystem health and provide a climate impact buffer from sea level rise and wildfires.

On the seismic front, the earthquake retrofit offered significant benefits but was not a "silver bullet" to the Bay Area's seismic risk. The retrofit strategy did not reduce damage by 100% for a few reasons. First, the retrofit was only applied to two of the worst-performing building types, totaling roughly 250,000 units; over 1 million other pre-1970 homes were not modeled with a retrofit. Second, shaking was only responsible for roughly 75% of the damage. Based on previous work for the HayWired project, a year 2035 Hayward earthquake would likely cause fires following the earthquake. While fewer seismically damaged buildings would likely reduce fire damage by some degree, the risk for fire following earthquake remained in Futures Round 2 because no mitigation strategy for urban fire risk was applied. Third, retrofit strategies never guarantee zero damage, but rather they provide great reductions to the odds of damage. In some isolated pockets, even with a retrofitted building, the shaking may be so intense because of the unique conditions of an individual earthquake that the building may still have severe damage.

Figure 9. Residential earthquake and sea level rise flooding damage in Round 1 and Round 2 analysis



Bold actions will be needed to reduce the Bay Area's transportation greenhouse gas emissions.

The Bay Area's transportation emissions are projected to decrease substantially over the next 30 years. In Futures Round 1, greenhouse gas (GHG) emissions reduction was driven by the electric vehicle external force assumptions for each Future, which ranged from 10% to 95% adoption levels by year 2050. The rate of electric vehicle adoption is a major contributor to the overall transportation sector emissions, and it is a well-known near-term step the Bay Area can take to relatively quickly reduce emissions. A discouraging trend in all three Futures was the large increase in VMT, driven in large part to the inclusion of autonomous vehicles. While making these new vehicles electric may reduce carbon impacts, the other challenges associated with auto trips, congestion and land use all remain and will require strategies beyond electrification to solve.

The adjusted land use pattern and new investments in transit and active modes also contributed to the reduction in transportation-related greenhouse gas emissions. In all three Futures the share of auto trips declined in both Round 1 and Round 2. But even in Clean and Green, the future where driving was assumed to be very expensive, the majority of the trips in the Bay Area continued to be made in automobiles. New transit lines and improved transit frequency offered low-carbon travel options and saw reduced VMT in areas served by new investments. The biggest strategy-driven shift was the investment in active transportation infrastructure and the corresponding increase in active mode share – a promising finding that will continue to be explored in the next analysis phase.

As ABAG and MTC transition from Horizon to Plan Bay Area 2050, it is important to remember that the large GHG reduction values shown in Figure 10 are not the same as the statutorily required 19% per-capita reduction target. Many of the factors that are behind the realized reductions in Horizon, like electric vehicle adoption powered by state and federal requirements, are ones the Bay Area cannot count toward meeting its statutorily required per-capita reduction target. The Bay Area will have to explore bold strategies to specifically reduce VMT if the ambitious 19% per-capita target is to be met.

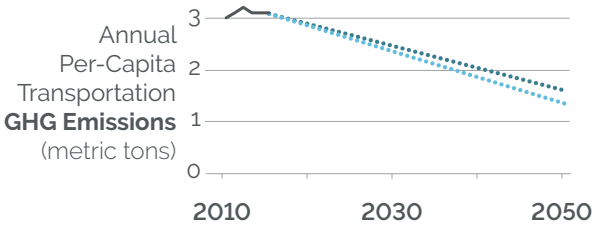
Figure 10. Per-capita transportation GHG emissions and natural land losses in Round 1 and Round 2

Rising Tides, Falling Fortunes

10% electric vehicle share; 3 feet of sea level rise

Round 1 **48%** Round 2 **56%**

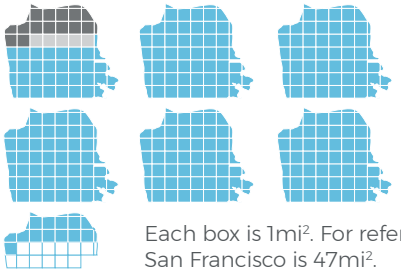
Reduction in 2015 Per-Capita Greenhouse Gas Emissions From Transportation Sources



Land Loss

Natural lands urbanized or permanently flooded in square miles, shown in relation to the size of San Francisco.

- 13 mi² urbanized in Round 1 and Round 2
- 5 mi² additional urbanized land in Round 2
- 300 mi² flood in Round 1 and Round 2
- 12 mi² flood in Round 1 but are adapted in Round 2



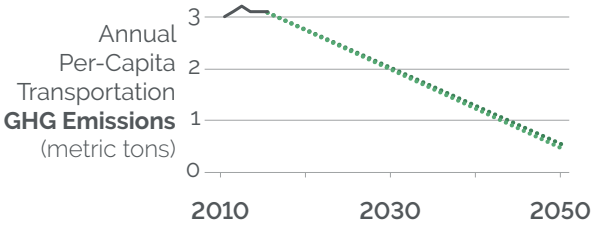
Each box is 1mi². For reference, San Francisco is 47mi².

Clean and Green

95% electric vehicle share; 1 foot of sea level rise

Round 1 **83%** Round 2 **86%**

Reduction in 2015 Per-Capita Greenhouse Gas Emissions From Transportation Sources



Land Loss

Natural lands urbanized or permanently flooded in square miles, shown in relation to the size of San Francisco.

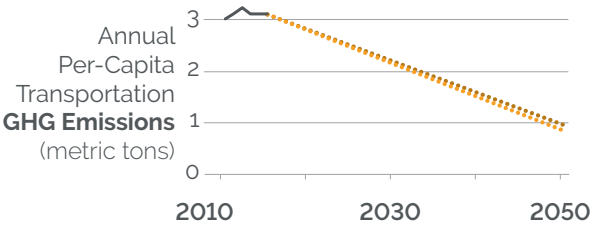
- 20 mi² urbanized in Round 1 and Round 2
- 2 mi² additional urbanized land in Round 2
- 44 mi² flood in Round 1 and Round 2
- 156 mi² flood in Round 1 but are adapted in Round 2

Back to the Future

75% electric vehicle share; 2 feet of sea level rise

Round 1 **69%** Round 2 **73%**

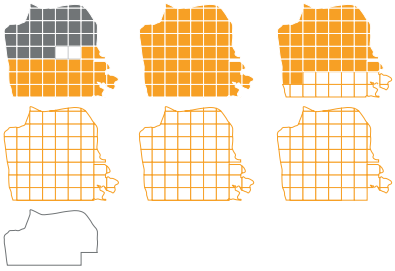
Reduction in 2015 Per-Capita Greenhouse Gas Emissions From Transportation Sources



Land Loss

Natural lands urbanized or permanently flooded in square miles, shown in relation to the size of San Francisco.

- 25 mi² urbanized in Round 1 and Round 2
- 2 mi² less urbanized land in Round 2
- 104 mi² flood in Round 1 and Round 2
- 156 mi² flood in Round 1 but are adapted in Round 2



VIBRANT

The vibrancy of the Bay Area's economy is defined by both the growth in economic output as well as the opportunity for all residents to be upwardly mobile in the future. Over the past two decades, the Bay Area economy grew by 40%, driven partly by a larger workforce but mostly by an increasingly productive region with a greater share of high-wage jobs. While the overall economy has grown, the Bay Area continues to lose jobs in middle-wage industries. In each Future, the size of the economy and the percent of jobs in middle-wage industries are projected. The projected size of the regional workforce and assumptions about worker productivity propel the three distinct Futures.

Where jobs locate is also a core factor for Bay Area land use and transportation decisions. New jobs tend to locate in areas with existing job concentrations, a phenomenon known as agglomeration. This occurs for several reasons, including the preexistence of infrastructure – office buildings, roadways, utilities and the like – and the efficiencies of being located near related businesses, suppliers and buyers. External forces, such as preferences for jobs located centrally or throughout the Bay Area, and policies carried over from Plan Bay Area 2040 also shape the jobs landscapes in the Futures. For example, existing caps on job growth, such as San Francisco's Proposition M and similar measures in a few other job-rich cities, limit the number of new jobs that can locate in those jurisdictions. These conditions are reflected in the land use modeling, which projects where different sector job growth is likely to occur into the future.

In Futures Round 1, the Bay Area economy grew at varying rates based on global and national level assumptions. In Rising Tides, Falling Fortunes, an assumed slower rate of global economic growth slowed the Bay Area economy, with the region adding fewer jobs over the next 30 years than it did over the past decade. In Clean and Green and Back to the Future, the overall economy grew at a similar rate, rising to roughly $2 trillion in 2050, but the growth was driven by different assumptions. In Clean and Green, this growth was supported by assumptions that worker productivity (the amount of value each worker adds) would increase at a faster rate than in recent years, which was linked to an assumption that automation would make workers more productive. This increased productivity led to a strong economy but only moderate job growth relative to the Bay Area's population. In Back to the Future, the economy grew at a pace with the Bay Area's overall population growth. In all three Futures, the sectoral growth showed similar trends, with historically middle-wage industries declining in their share of job mix but with professional and health services increasing. Finally, in Futures Round 1, the Bay Area continued to see a disproportionate share of job growth in the West Bay, continuing the region's long-standing jobs-housing imbalance.

In Futures Round 2, a set of strategies was tested to specifically increase the share of middle-wage jobs and direct greater job growth to portions of the North Bay and East Bay. New strategies expanded benefits for part-time and freelance workers, and new childcare subsidies were applied to provide direct financial support to low-income households in order to lessen their cost-burdened status and increase economic opportunity for parents. Strategies focused on expanding middle-wage construction workforce jobs as well as the creation of incubator programs attempted to provide pathways to the middle class. Finally, two strategies aimed to steer new office development toward locations that have both low VMT and are housing rich. To do this, fees and office development caps were studied.

Generally, the package of strategies tested had only limited success in leading to a transformative shift in the makeup of the Bay Area economy and the location of jobs. Attempting to combat global and national level trends of the declining middle-wage job sector at the regional level continues to be an uphill challenge. The construction workforce training program had marginal success in comparison to the effect of major capital spending on major initiatives and projects (e.g., new affordable housing construction, sea level rise adaptation and new transit lines). Altering the location of new office development is likely to require a much stronger alignment in regional economic development goals as well as collaboration with Bay Area employers. The office cap in job-rich cities saw some shifts at the city level, but portions of Contra Costa County and the North Bay remained unchanged with the policy.

Regional policies are likely to struggle in reversing a national trend of declining middle-wage jobs, which serve an important role in enabling economic mobility in an increasingly inequitable era.

A number of strategies attempted to increase the share of middle-wage jobs, but none of the studied policies were effective when applied in the MTC and ABAG models. The largest shift in sector with disproportionately high shares of middle-wage jobs between Futures Round 1 and Round 2 was driven by the overall tax package and investment strategy. The construction sector benefited from new taxes contributing billions of new dollars annually to build new affordable housing, expand the transportation system and adapt the shoreline. Other sectors that grew slightly as a result of the new strategies were the social services and transportation sectors, reflecting some of the major investments such as childcare and expanded transit operations. Despite many of these sectors having a significant number of middle-wage jobs, the move of a few thousand or as many as ten thousand jobs to these sectors does not translate beyond a single percentage point shift in the overall Bay Area economy sector share.

MTC and ABAG staff remain interested in preserving existing middle-wage jobs and growing the sectors when possible, while recognizing that national trends and national policies will play a much greater role on this critical issue area of economic mobility. One strategy not studied in Futures was the Priority Production Area (PPA) designation and complementary strategies for these locations. As MTC and ABAG staff work to continue to define the PPA strategy package for Plan Bay Area 2050, advancing middle-wage jobs and the location of those jobs will remain a core goal of the strategy. The job incubator strategy also remains a strategy that might offer both opportunities for upward economic mobility as well as the ability for the Bay Area to focus such investments in select cities to strengthen PPAs or produce marginal shifts in the jobs-housing balance.

Figure 11. Overall and industry job growth in Round 1 and Round 2

		RISING TIDES, FALLING FORTUNES	CLEAN AND GREEN	BACK TO THE FUTURE
Overall job growth in the three Futures, and the Additional Job Growth as a result of the Round 2 strategies.	Round 1 Job Growth (2015-2050)	**524,000**	**1,088,000**	**2,738,000**
	Additional Jobs as a Result of Round 2 Strategies	**12,000**	**18,000**	**30,000**
	Percent Increase	**2%**	**2%**	**1%**
Industry sectors that grew the most between Round 1 and Round 2 (Rank, (Increase in sector jobs between Round 1 and Round 2)**).**	Construction	**1** (4,500)	**1** (6,000)	**1** (9,500)
	Social Services	**7** (500)	**2** (2,000)	**2** (3,000)
	Transportation and Warehousing Services	**2** (2,000)	**3** (1,500)	**3** (2,500)
	Health Services	**3** (1,000)	**5** (1,500)	**4** (2,500)
	Government, Public Administration	**6** (500)	**4** (1,500)	**5** (2,500)
	Food and Drink Services	**5** (500)	**6** (1,000)	**6** (2,000)
	Professional Services	**4** (500)	**7** (1,000)	**7** (1,500)

Rising Tides Falling Fortunes had a more pronounced difference from the other two Futures because only a portion of new strategies were applied to that slow growth, lower revenue Future.

Strategies that influence job locations had mixed results; bolder strategies or new ideas will be needed to change the regional pattern of where future jobs locate.

In Futures Round 2, jobs did move slightly around the Bay Area, but patterns from the present largely remained. The right side of Figure 12 shows which areas had job growth or loss compared to Futures Round 1 analysis and displays how the full package of new strategies altered where jobs grew. The reasons for change are dynamic with dozens of strategies at play, including growth framework zoning changes, commercial development fees in areas with high employment-related VMT and office development caps in today's most job-rich cities.

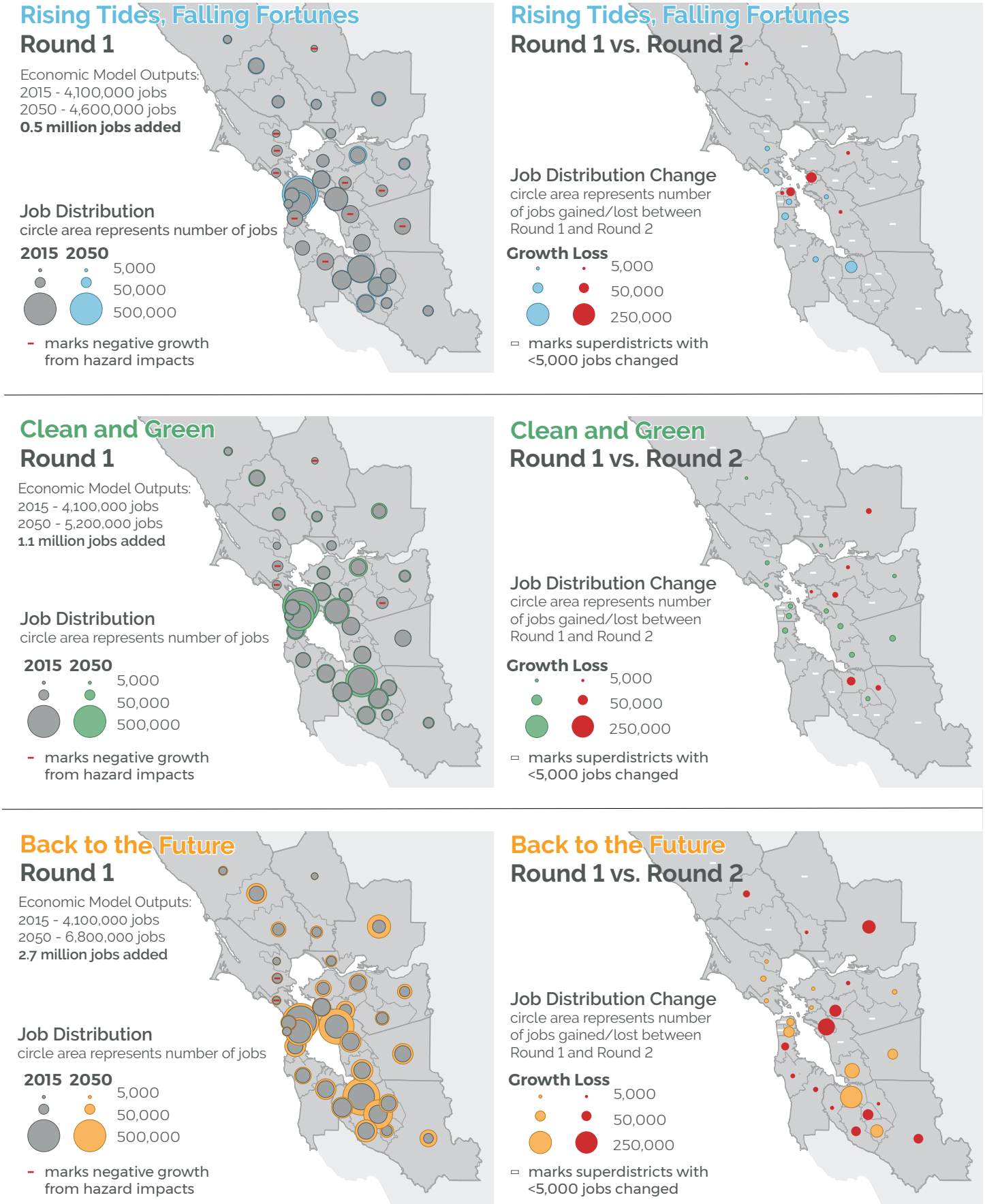
Two strategies were designed to specifically influence the location of new jobs. A commercial development fee in areas with high employment-related VMT, a legacy Plan Bay Area 2040 strategy, was successful in locating new office jobs in areas with low VMT, primarily locations near higher-frequency transit service. Figure 12 highlights the success of the VMT-based commercial development fee in locating most office jobs in areas with low employment-related VMT, but as described in Chapter 4, this strategy is also acting as a deterrent to office development in many North Bay areas and the eastern side of East Bay counties. ABAG and MTC staff have already begun testing variations of this strategy, including exploring how a county-based average rather than a regional average might shift more jobs to housing-rich locations, even if this reduces its efficacy on GHG reduction to an extent.

The other location-based job strategy tested a cap on new office development in communities with a high jobs-to-housing ratio. This strategy did result in a modeled shift of jobs to the East Bay – primarily Alameda County – but the model was not able to capture the possibility of jobs leaving the Bay Area altogether as a result of the strategy instead of relocating to other Bay Area cities. This strategy was most successful in Back to the Future, which had a greater number of jobs that had to be redistributed as a result of the cap (see the Back to the Future job shifts in Figure 11).

Many other strategies greatly influenced the shifting of jobs between Futures Round 1 and Round 2, a dynamic that may not be intuitive. The large job increase in northern Santa Clara County seen in both Back to the Future and Rising Tides, Falling Fortunes is largely a reflection of sea level rise adaptation measures preventing flooding of office buildings in Futures Round 1 that occurred as sea levels rose 2 and 3 feet, respectively. A similar trend is seen in Marin County where adaptation measures protected jobs in all three sea level rise scenarios and led to an increase in jobs in Futures Round 2.

Finally, it is worth noting that a portion of the jobs-housing imbalance was made more severe in Futures analysis because of the modeled 2035 earthquake. In particular, the communities along the I-880 and I-80 corridor from Fremont to Richmond experienced serious job growth obstacles in recovery from the 2035 earthquake, which would destroy both homes and businesses. In Futures Round 2, a modeled residential seismic safety strategy reduced residential damage, but the strategy did not reduce business impacts. This corridor, absent an earthquake, would have greater job growth in both Futures Round 1 and Round 2. This factor does not explain the less than desired job growth and jobs-housing balance for North and East Bay communities farther away from the Hayward Fault. The modeled earthquake highlights the negative economic consequences that an earthquake can have anywhere in the Bay Area. The larger trend of the Bay Area's jobs-housing imbalance requires further analysis and strategy considerations in the first phase of the Plan Bay Area 2050 Blueprint, given the robust interest in this topic area.

Figure 12. Distribution of job growth in Round 1 and the change in distribution between Round 1 and Round 2



Exploring Performance Gains From Futures Round 2 Strategies

The set of strategies studied in Horizon had mixed results. In some cases, existing strategies from Plan Bay Area 2040, when combined with external forces, led to strong performance in Futures Round 1. For example, growth in gross regional product as well as minimal greenfield development were already in effect during Round 1 analysis. Futures Round 2 strategies made substantial headway on issues of affordability and connectivity, with new housing strategies helping to drive down the extreme costs in the Bay Area and investments in alternatives to driving shifting mode share away from the automobile in all Futures. The area for which strategies made the least progress was the diverse Guiding Principle – ultimately, the Futures Round 2 strategy package did little to diminish displacement risk or enable greater economic opportunities for lower-income residents. Going into the Blueprint phase of Plan Bay Area 2050, this will be a key area to consider more ambitious strategies to achieve more equitable outcomes for all.

Table 5. Guiding Principle scorecard and progress made between Round 1 and Round 2

GUIDING PRINCIPLE		RISING TIDES, FALLING FORTUNES			CLEAN AND GREEN			BACK TO THE FUTURE		
		2050 Value		Rd. 1 v Rd. 2	2050 Value		Rd. 1 v Rd. 2	2050 Value		Rd. 1 v Rd. 2
AFFORDABLE	Housing costs (Share of income)	Rd. 1	–	–	Rd. 1	–	↓	Rd. 1	–	↓↓
		Rd. 2	–		Rd. 2	–		Rd. 2	–	
	Affordable housing production (New deed restricted units, 2015-50)	Rd. 1	232k	–	Rd. 1	309k	↑↑	Rd. 1	388k	↑↑
		Rd. 2	237k		Rd. 2	424k		Rd. 2	555k	
CONNECTED	Non-auto commute mode share	Rd. 1	39%	↑↑	Rd. 1	59%	↑↑	Rd. 1	37%	↑
		Rd. 2	43%		Rd. 2	63%		Rd. 2	39%	
	Average commute time (minutes)	Rd. 1	39 min	–	Rd. 1	40 min	↑	Rd. 1	49 min	–
		Rd. 2	38 min		Rd. 2	42 min		Rd. 2	48 min	
DIVERSE	Risk of displacement (share of lower-income HHs)	Rd. 1	24%	–	Rd. 1	46%	–	Rd. 1	33%	–
		Rd. 2	25%		Rd. 2	47%		Rd. 2	32%	
	High Resource Area income diversity (share of low-income HHs in High Resource Areas)	Rd. 1	36%	–	Rd. 1	33%	–	Rd. 1	31%	↑
		Rd. 2	35%		Rd. 2	34%		Rd. 2	33%	
HEALTHY	GHG emissions (in tonnes per capita)	Rd. 1	1.60	↓↓	Rd. 1	0.52	↓	Rd. 1	0.95	↓
		Rd. 2	1.35		Rd. 2	0.44		Rd. 2	0.84	
	Annual greenfield development (acres)	Rd. 1	250	–	Rd. 1	375	–	Rd. 1	475	–
		Rd. 2	350		Rd. 2	400		Rd. 2	425	
VIBRANT	Jobs in middle-wage industries (share of all jobs)	Rd. 1	18%	–	Rd. 1	17%	–	Rd. 1	19%	–
		Rd. 2	18%		Rd. 2	17%		Rd. 2	20%	
	Gross regional product (inflation adjusted per-capita)	Rd. 1	$130k	–	Rd. 1	$192k	–	Rd. 1	$135k	–
		Rd. 2	$130k		Rd. 2	$192k		Rd. 2	$136k	

GREAT | GOOD | NEUTRAL | BAD | TERRIBLE

CHAPTER 4

IDENTIFYING EFFECTIVE STRATEGIES

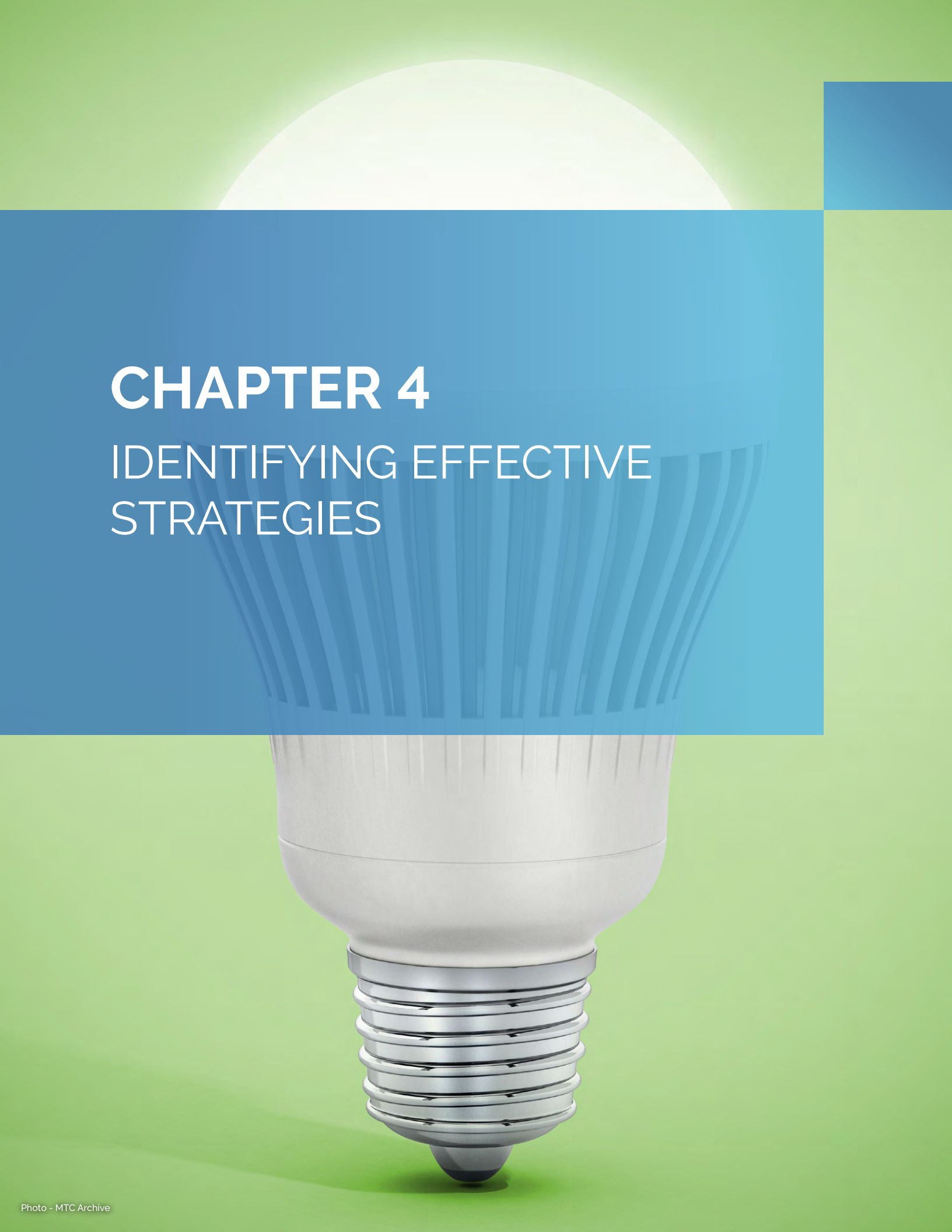


Photo - MTC Archive

IDENTIFYING EFFECTIVE STRATEGIES

The previous section described how a packaged set of new strategies focused on the economy, housing, transportation and the environment resulted in different outcomes in each Future. This section focuses on the specific effects of individual strategies, in line with Horizon's aim to identify resilient and equitable strategies for potential advancement into Plan Bay Area 2050.

Most strategies were analyzed individually using the model most appropriate to understand individual impacts: REMI for economic strategies, UrbanSim 1.5 for housing and environment strategies, and Travel Model 1.5 for transportation strategies. When individual model runs were not available or not possible due to modeling limitations, staff relied on literature reviews or companion analyses to provide supplemental information on the effect of a strategy.

In the following chapter, strategies have been organized by the four topical areas and summarized using a consistent schema. In total, 34 strategies are described in this section – some are evolutions of existing Plan Bay Area 2040 strategies, while many are new, previously unstudied Horizon strategies. The schema used to structure this chapter is as follows:

Description: This section includes background information on the challenge the strategy is attempting to address as well as the defining elements of each strategy.

Strategy Rating: Given interest in understanding which strategies are best positioned to advance in Plan Bay Area 2050 – based on staff analysis to date – MTC and ABAG have assigned a Horizon rating, weighing the pros and cons of each strategy. This rating does not determine whether a strategy moves forward or not, but it provides an early indication of strategies that staff recommends for further consideration and refinement during the Plan Bay Area 2050 process.

The four ratings are:

1. ○●●● **Recommended to move forward.** Strategies with this rating were very resilient to an uncertain future (likely performing well in all three Futures), yield significant benefits towards Horizon Guiding Principles, and advance equitable outcomes.
2. ○○●● **Recommended to move forward with minor adjustments.** Strategies with this rating were generally resilient to an uncertain future (perhaps performing well in two of the three Futures) and have significant benefits. Further refinements might make them more effective or more equitable.
3. ○○○● **Significant revisions needed for inclusion.** Strategies with this rating did not prove sufficiently resilient to an uncertain future or had significant unintended consequences, such as adverse equity impacts on low-income populations. Significant revisions should be considered before advancing this strategy.
4. ○○○○ **Already moving forward due to state legislative action.** Over the course of the past year, significant legislative action at the state level has advanced several of the Horizon strategies into implementation. These strategies are recommended for inclusion in the baseline, given that they are now state law.

Pros and Cons: Using modeling results, literature reviews and feedback received during the planning process, this section lists the most significant pros and cons associated with each strategy.

Key Figure: When appropriate, an infographic offers a visual representation of at least one associated strategy finding.

Technical Notes: This section documents the key assumptions and/or methodology used to define and test strategies. For readers who want to understand the analytical details, this offers a more detailed description of how a strategy was modeled. Superscript references are used throughout this chapter to identify the model or the literature that was used to support the finding. Findings with superscript REMI, US, and TM were developed with REMI, UrbanSim, and the Travel Models; endnotes typically reflect literature review supported findings.

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ECONOMY

Improve Economic Mobility

In the first round of Futures analysis, all three Futures saw the middle class continue to shrink. A set of four economic development strategies were aimed at increasing upward mobility opportunities and providing greater support for low-income households. Despite the Rising Tides, Falling Fortunes having the greatest economic challenges of the three futures, only two of the four strategies were included in that Future, as available revenues are much more limited due to the weak economy.

- Provide Portable Benefits for Part-Time and Freelance Workers
- Create Incubator Programs in Economically Challenged Communities
- Provide Childcare Subsidy for Low-Income Households
- Expand Construction Workforce Training Programs

Shift the Location of Jobs

Many stakeholders are interested in understanding how strategies can be used to focus future job growth in areas close to public transit and in housing-rich communities. In Plan Bay Area 2040, a commercial development fee based on average vehicle miles traveled (VMT) per-worker was used to discourage new commercial construction outside of Transit Rich Areas and commercial development caps were assumed to be placed in two Bay Area cities. The second round of Futures analysis built off these two policies but went further to study the effect of expanded strategies.

- Implement Regional Office Development Impact Fees
- Place Office Development Caps in Job-Rich Locations

CHALLENGE

More than one-third of Bay Area workers have no employer-offered retirement plan and have no paid time off; another 6% are not eligible for unemployment insurance. Without a new strategy, this challenge would remain constant — all three Futures had a similar share of 2050 jobs in industries with high rates of part-time workers and limited benefits[REMI,2].

STRATEGY

Change state employer requirements and levy customer transaction fees to increase retirement, unemployment insurance and paid time off benefits for workers who currently do not receive these benefits.

RATING: Already moving forward due to state legislative action

In September 2019, the California legislature passed AB 5, which expands unemployment insurance coverage for "gig economy" workers and basic protections for paid sick and family leave. This change reclassifies employees and requires companies to pay related costs for providing employees disability and retirement benefits. In theory the gig company would cover benefit costs, but in practice, it could come out of the employee's revenue. Our analysis suggests that this legislative action would lead to significant positive benefits across all three Futures for "gig economy" workers.

PROS

- **These benefits can help smooth household earnings.** A greater share of Bay Area residents with these benefits helps to smooth earnings to reduce the shocks in life that commonly lead to negative outcomes like eviction[3]. Given the relatively similar shares of workers of this type in all three Futures, this strategy has a greater likelihood of resilience in an uncertain future.
- **Residents covered by retirement benefits will be increasingly important.** In all three Futures, the region's fastest growing age cohort are seniors. All three Futures have over one million new seniors, making up nearly all the growth in Rising Tides, Falling Fortunes[REMI]. A strategy that may reduce incomes in working years but that provides a larger long-term gain in retirement benefits would improve the financial stability of an aging region.

CON

- **A state-level rather than national-level policy could hinder some remote contract work.** If all else remains the same, remote work with added costs in California could make some contractors less competitive than remote workers in other states. For local "gig economy" services that by their nature have to occur within the state, a state-level policy would not have this challenge[4,5].

TECHNICAL NOTES

To better understand this strategy's pros and cons, a **qualitative literature review approach** was used in support of demographic and job sector outputs from **Regional Economic Model Inc (REMI)**. Borrowing from methodology and findings from a 2015 study by a Monthly Labor Review article[6], MTC and ABAG staff studied the rates at which different sectors offer benefits. The methodology used data from the National Compensation Survey (NCS). Other papers were used to support additional findings related to appropriateness of different government scales implementing the policy[7,8].

CHALLENGE

In Futures Round 1, job growth continued to occur disproportionately in the West Bay, accentuating the Bay Area's longstanding jobs-housing imbalance. Residents in East and North Bay communities had less access to job opportunities, which creates challenges related to upward economic mobility. Starting a new business is difficult anywhere but is made harder without existing nearby businesses or a cluster of interconnected firms with which to leverage co-location benefits.

STRATEGY

Fund pre-incubation services (technical assistance for establishing a new business), as well as access to workspaces, mentorship and financing in disadvantaged communities with lower jobs to housing ratios.

RATING: Recommended to move forward with minor adjustments

A regionally supported incubator program allows for a more active approach to locate new businesses and jobs in a specific location. Further research is needed to explore the effectiveness and best practices of incubators focused on developing businesses in new markets[9,10,11]. This strategy potentially could be combined with both Priority Production Areas and Priority Development Areas in housing-rich locations to encourage job opportunities specifically located in places where future job growth is intended to be focused.

PROS

- **Silicon Valley is home to many of the most effective incubators.** The Bay Area has businesses and organizations that are among the most effective in launching new businesses[12]. Recent incubator successes like La Cocina, which helps immigrant and low-income food entrepreneurs from communities of color formalize or expand their businesses, are now providing knowledge sharing for other immigrant- and women-owned businesses[13].
- **While many incubators operate near research universities, there are examples of co-locating with community colleges.** The Bay Area could seek to emulate the model used by PhillyiHub, a coworking space and educational center in a partnership with the local initiative support corporation (LISC) and community college[14].

CON

- **Incubators, like many new businesses, have a high rate of business failure.** With or without incubator services, 20% of businesses fail in the first year, and 50% fail in the first five[15]. Incubators are designed to start new businesses, but businesses born out of incubators have been shown to fail 10% sooner than non-incubated businesses[16,17].

TECHNICAL NOTES

To better understand this strategy's pros and cons, a qualitative literature review approach was used. Literature on incubators highlights the challenges associated with supporting new businesses[18,19]. The Bay Area has many examples of effective incubators, but many incubators are focused on leveraging existing market strengths in Silicon Valley and Bay Area research universities[20].

CHALLENGE

Average Bay Area childcare costs are more than $15,000 per year, which poses a financial challenge, particularly for low-income households already impacted by the Bay Area's high cost of living[21]. Today, approximately 75,000 Bay Area households earn less than $50,000 annually with at least one child 5 years old or younger.

STRATEGY

Provide a 50% childcare subsidy to low-income households with children under 5, enabling more parents with young children to remain in (or to enter) the workforce.

RATING: Recommended to move forward with minor adjustments

The equity benefits of affordable childcare are broad: It improves career trajectories for women and reduces financial burden for working-class families. Neither ABAG nor MTC would lead in this strategy's implementation but the agencies could advocate for supportive policies to be advanced by others as part of future economic development work. Future work should further consider the income threshold for this strategy, the level of financial support, any appropriate restrictions to eligibility and how the high cost of such subsidies could be funded.

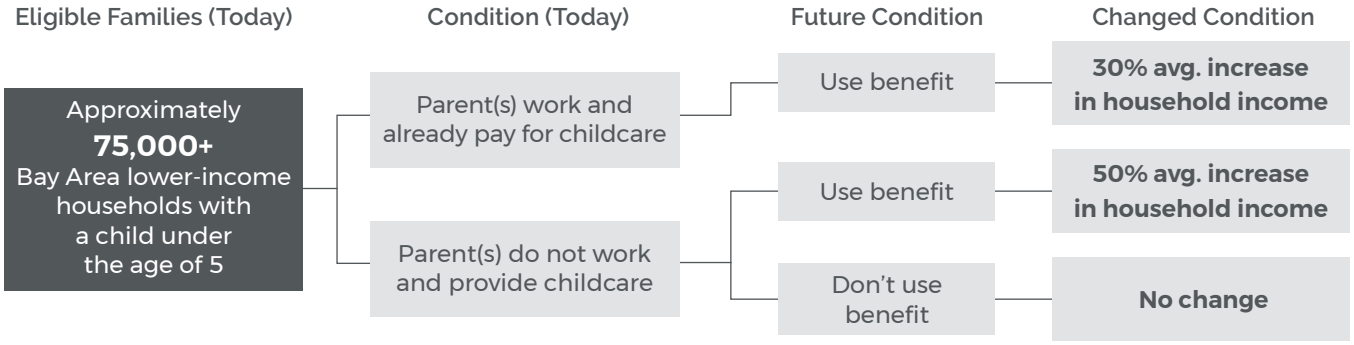
PROS

- **For households with parents already working, the benefit could raise income by 30% or more.** Providing a benefit for families that are already paying for childcare would reduce the childcare burden on their budgets.
- **For households with a parent currently providing childcare and not working, the benefit could raise income by 50% or more.** With each 10% reduction in childcare costs, research indicates that there is a corresponding 0.5 to 2.5 percentage point increase in the female labor force participation rate[22,23]. For Clean and Green and Back to the Future, this policy is estimated to potentially increase the labor force by roughly 5,000, which would further strengthen the Bay Area's economy[REMI]. The positive effects are particularly pronounced for single parents[24].

CON

- **The program is expensive, with continuous annual costs to continue subsidizing childcare.** Providing the benefit in perpetuity would require roughly $700 million annually or more. The two higher-growth Futures, Clean and Green and Back to the Future, would likely have significantly higher program costs with a larger future youth population. In Rising Tides, Falling Fortunes, the program costs would remain high despite fewer youth because of the increase in low-income households.

Figure 13. Benefit effect on household income for different household types



TECHNICAL NOTES

To better understand this strategy's pros and cons, a **qualitative literature review approach** was used, then integrated into the **REMI economic model**. MTC and ABAG staff used 2016 ACS PUMS 1-year data to determine the number of low-income households earning less than $50,000 with at least one child. Pulling from recent reports, staff assumed childcare costs at $1,500 per month[25] and used literature to estimate maternal labor force participation rate factors[26,27] to estimate an increase in the labor force. Staff are unable to estimate how many low-income households have parents who are or are not working, so the impacts were studied separately with maternal employment integrated into the Futures Round 2 REMI modeling. The assumed increases in household income shown in Figure 13 assume the shift is based on households with a single child 5 years old or younger.

CHALLENGE

Ever since the Great Recession in 2008, the Bay Area construction workforce has been particularly tight — it was the most hard-hit sector in the Bay Area economy with the workforce shrinking 33% between 2007 and 2010, whereas the overall job loss in the region was under 7% during that time period. The construction labor force is smaller today than it was in 2006.

STRATEGY

Provide increased funding to existing construction workforce training programs and continued financial support to early career workers through their lower-wage apprenticeship years. Provide increased training opportunities to 1,000 workers annually.

RATING: Significant revisions needed for inclusion

ABAG and MTC models showed the strategy, as currently described, will have a limited impact in growing the construction sector. While it is critical to expand the construction workforce to meet economic development aims to advance middle-wage jobs and to build much-needed housing, more research around an effective policy to achieve the goal is needed, possibly exploring strategies that reduce the sector's volatility during recessions.

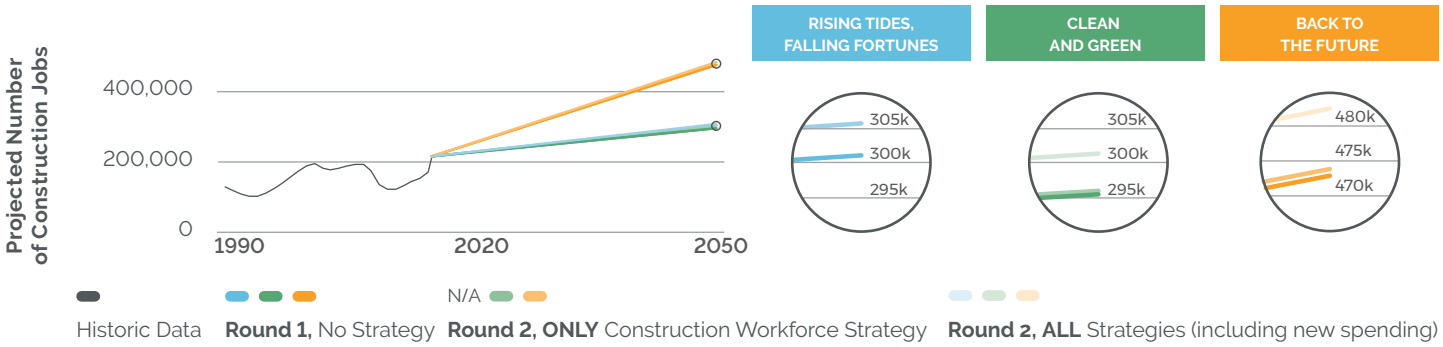
PROS

- **The strategy grows the regional construction workforce by up to 1,000 workers.** Albeit small, the strategy did increase the construction workforce. The cumulative impact of additional construction workers compounds over decades. While 1,000 workers were trained annually, the model projected most would not remain in the field, suggesting training may not be the best strategy; instead, housing to match construction workforce incomes may be more effective.
- **The three Futures may not need an incentive strategy.** The strategy may not perform well because construction was one of the fastest growing sectors in the Round 1 analysis. In Round 1 the construction sector grew from 5.2% of the Bay Area labor force today to 5.8% in Clean and Green, 6.5% in Rising Tides, Falling Fortunes, and 7.0% in Back to the Future[REMI].

CONS

- **When isolated, the strategy resulted in less than a 1% increase in the number of construction jobs**[REMI]. There was a minimal increase in the workforce as a result of the strategy. Instead, creating new construction jobs was more effectively advanced by new spending by other strategies (e.g., new affordable housing, new infrastructure). The new spending generated a several percentage point increase in sector growth between the analysis rounds (see Figure 14).
- **The strategy did not reduce construction costs significantly.** Likely a reflection of limited construction labor growth, the compensation rate for the sector remained steady with and without the strategy.

Figure 14. Effect of construction workforce strategy on construction sector job growth



TECHNICAL NOTES

To better understand this strategy's pros and cons, the **REMI economic model** was leveraged. The construction occupation labor supply was increased by 1,000 trained workers annually in the model. The model then distributed the trained workers into different industries, with some joining the construction sector, while the model showed the vast majority of the trained workers joining other industries.

Implement Regional Office Development Impact Fees

RATING ●●○○

CHALLENGE

Employment centers located in areas that require long vehicle commutes and that do not offer alternative means of transportation can lead to greater emissions and more traffic congestion.

STRATEGY

Apply a fee on new office development in areas that have high employment-related vehicle miles traveled (VMT). Assigned on a per square foot basis, the fee is highest in areas with the greatest VMT and zero in areas with the lowest. The fee revenues incentivize development inside low-VMT job centers.

RATING: Recommended to move forward with minor adjustments

This strategy was adopted in Plan Bay Area 2040, and through ABAG and MTC modeling, it has proven effective in incentivizing job growth in low-VMT locations across multiple Futures. Building upon existing statutory authority, this might take the form of an indirect source rule, which has been implemented in the San Joaquin Valley, or a commercial linkage fee that could generate revenue for affordable housing. In Plan Bay Area 2050, revisions to the strategy could include updating the zones and fees and tailoring this strategy to reflect county-level conditions — rather than "one size fits all" — to ensure it does not reinforce the existing jobs-housing imbalance. Furthermore, the strategy could be refined to more closely align with the provisions of recently-passed Assembly Bill 1487.

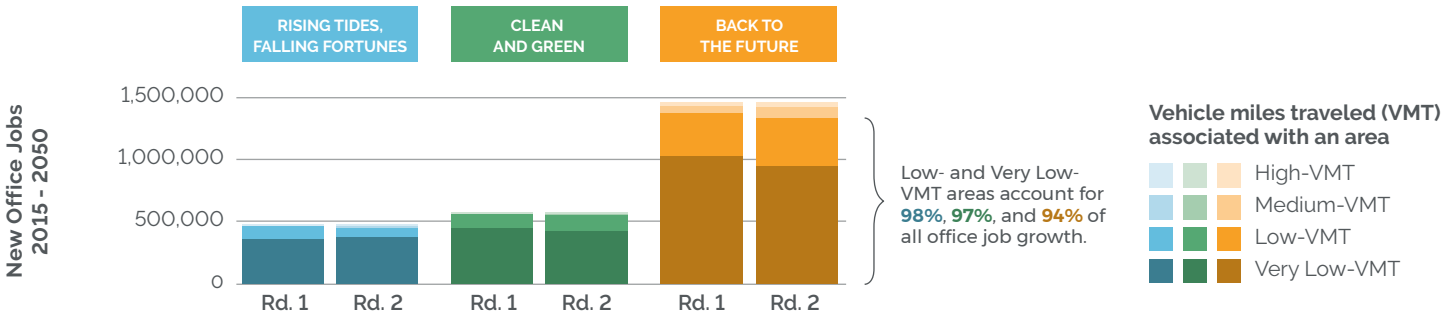
PROS

- **Over 90% of new office jobs were located in areas with associated very low or low VMT**[US]. The strategy, studied in both rounds of analysis, had nearly identical results — approximately 95% of new office jobs located in very low- and low-VMT zones and most located in the very low-VMT zone. The effectiveness tapered slightly in Back to the Future, potentially reflecting that low-VMT zones become "built out," pushing development to higher VMT zones despite the fee.
- **The strategy raises new revenue to support development near transit**[US]. The difference between Futures Round 1 and Round 2 analysis were that fees in Round 2 were doubled. In Futures Round 1 the fee generated $660 million to $4.6 billion in revenue over 30 years, growing to $1.4 billion to $10.8 billion in Futures Round 2 due to the fee doubling.

CONS

- **The fee greatly disincentivizes office-sector job growth outside many Bayside communities.** Office space development across much of the North Bay counties as well as portions of Alameda and Contra Costa counties is restrained by the fee structure, limiting the ability to address the regional jobs-housing imbalance. A more nuanced approach might consider county conditions, reducing or eliminating fees in some moderate-VMT zones of generally high-VMT counties.
- **Doubling the fee did not result in increased development in very low-VMT areas**[US]. The doubled fee saw negligible differences, suggesting the original fee was sufficient to influence the location of development. If considered in Plan Bay Area 2050, further analysis may help inform a fee value.

Figure 15. Location of new office-related job growth relative to an area's associated VMT level



TECHNICAL NOTES

To better understand this strategy's pros and cons, **the UrbanSim 1.5 land use model** was used to simulate the strategy, both individually and as part of a package. The results above are from the isolated model runs that also incorporated Plan Bay Area 2040 zoning and streamlining assumptions. Commute-related VMT associated with jobs in each Travel Analysis Zone (a small area geography) were calculated and broken apart into low- to high-VMT categories. The fee was $0 to $120 per square foot in Round 1, and it ranged from $0 to $240 in Round 2. The strategy focuses on office-related sectors of the economy, as opposed to all jobs.

CHALLENGE

Futures Round 1 saw a continuation of today's jobs-housing imbalance in all three futures with San Francisco, the Peninsula and Silicon Valley continuing to attract jobs at a faster rate than other parts of the Bay Area. This imbalance is a contributor to traffic congestion and transit overcrowding, and it creates fiscal challenges for some housing-rich cities.

STRATEGY

Expand existing office development cap policies and strategies in San Francisco, Cupertino and Palo Alto to nine additional cities to limit further job growth in cities with the highest jobs-to-housing ratios.

RATING: Significant revisions needed for inclusion

The strategy merits further refinement before considering its advancement into Plan Bay Area 2050. Alameda County benefits from the strategy as tested in Futures Round 2, but there are significant economic risks from capping office development. Going forward, there are multiple paths the Bay Area could pursue. Many communities that are housing-rich are interested in a more nuanced and flexible strategy, such as a regional development fee targeting this same issue and integrating a nexus with transportation and housing impacts, that may be more effective and elicit greater support. On the other hand, a more expansive strategy may be more effective in shifting jobs from the South and West Bay to the East and North Bay — even as it poses greater economic risks with jobs potentially being shifted out of the Bay Area.

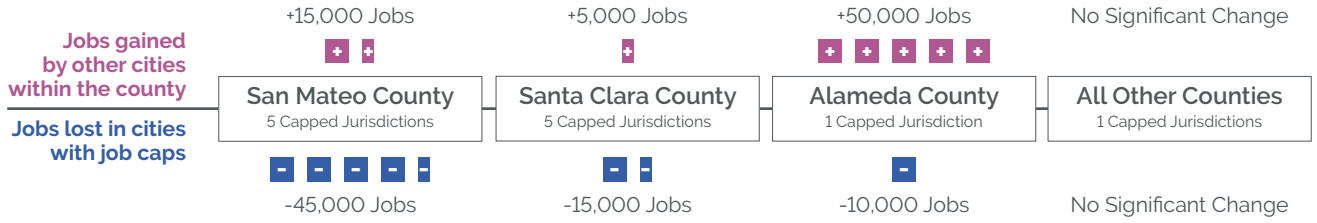
PROS

- **The strategy reduced the number of jobs in capped cities**[US]**.** In Clean and Green 35,000 fewer jobs and in Back to the Future 115,000 fewer jobs were located in the nine new office-capped cities. By reducing job growth, the combined jobs-housing ratio for the capped cities decreased but remained 10% to 30% above the regional average.
- **The strategy leads to somewhat greater East-to-West jobs balance**[US]**.** The model, which was unable to forecast jobs that might instead choose to locate outside of the region, projected many impacted jobs shifting to Alameda County. Roughly one-third of capped jobs moved to neighboring jurisdictions in the same county (such as Millbrae or San Jose), with Alameda County jurisdictions absorbing the other two-thirds (Berkeley, Fremont and San Leandro attracted the most). Benefits were minimal for Contra Costa County and most North Bay jurisdictions.

CONS

- **The cap may push some jobs out of the Bay Area**[28]**.** Companies in knowledge-sector industries benefit from working near firms doing similar work. If suitable alternatives within the region do not offer the same access to suppliers and skilled workers, some firms may expand outside the Bay Area. The cap could also result in higher operating costs that impact new or small businesses to a greater degree[29].
- **Many job-rich cities are opposed to the policy.** Like most land use strategies, this policy is something local government would need to pass and adopt voluntarily. As currently written, the strategy is unpopular with the Bay Area's most job-rich jurisdictions.

Figure 16. Effect of city office-cap policy on county-level job growth



TECHNICAL NOTES

To better understand this strategy's pros and cons, the UrbanSim 1.5 land use model was used to simulate the strategy, both individually and as part of a package. In Futures Round 1, San Francisco (i.e., Measure M), Palo Alto and Cupertino had office development caps or equivalent policies in place. In Futures Round 2, new caps were applied to cities with a 2.0 or greater jobs-housing ratio: five San Mateo County cities, three Santa Clara County cities and one Alameda County city (Emeryville). The strategy only affected office space development and did not affect planned or permitted projects. The cap had no effect in Rising Tides, Falling Fortunes because there was sufficient office space in the pipeline of known planned and permitted projects to support all office growth in that Future. Companion literature review was used to support the strategy's possible downsides[30,31].


Photo - Martin Klimek

HOUSING

Spur Housing Production

To improve the Bay Area's ability to meet its housing needs, Futures Round 2 analysis explored an expansion of the Priority Development Area (PDA) focus of Plan Bay Area 2040 Regional Growth Framework to increase housing construction for all income levels around all major transit stops and in high-resource communities. Large catalyst sites, often aging malls or aging office parks, were also identified as opportunity sites for mixed-use neighborhoods. Similar to how PDAs have been treated in past plans, all of these growth geographies were assigned higher allowable densities, with Transit Rich Areas assigned higher allowable densities than areas with more modest levels of transit service. Building upon the PDA strategy from Plan Bay Area 2040, all these growth areas were assumed to be eligible for development streamlining. The six strategies evaluated were:

- Allow a Greater Mix of Housing Types and Densities in Priority Development Areas
- Allow a Greater Mix of Housing Types and Densities Around All Major Transit Stops
- Allow a Greater Mix of Housing Types and Densities in High Resource Areas
- Streamline Development in All Areas Designated for Growth
- Transform Aging Malls and Office Parks Into Neighborhoods
- Repurpose Public Land to Build Housing

Retain and Expand Affordable Housing

To advance affordability and protections for lower-income households, three strategies were studied in Futures Round 2, including a strategy that supersedes the prior 10% inclusionary housing policy from Plan Bay Area 2040. Together, these strategies are designed to protect and build more deed-restricted affordable housing and reduce displacement risk. In the two higher-resource Futures, new tax revenues are applied to large-scale affordable housing preservation and production.

- Increase Renter Protections
- Fund Affordable Housing Preservation and Production
- Require 10% to 20% of New Housing to Be Affordable

CHALLENGE

The Bay Area continues to be an attractive place to live and work, which has led to continued regional growth. Cities and the larger region must consider where growth makes the most sense to achieve the best broad, long-term outcomes. Because the private market — not government — generally builds housing or commercial centers, Bay Area cities must use planning and policy tools to steer growth.

STRATEGY

Jurisdictions nominate areas near transit and adopt plans to allow future growth in those locations. MTC and ABAG partner with local jurisdictions to assist with planning and investment in these areas.

RATING: Recommended to move forward

Increasing development capacity in Priority Development Areas effectively focused growth in Futures Round 1 toward areas with robust transit service. Existing PDAs still attracted half of all development in Futures Round 2 when new, non-locally nominated locations were added. In September 2019, jurisdictions submitted 35 new PDA-eligible letters of interest, increasing the overall PDA footprint beyond what was studied in the Horizon analysis.

PROS

- **PDAs attracted a majority of the Bay Area's growth in both Futures analysis rounds**[US]. In Futures Round 1, three-quarters of the future growth across all the Futures occurred within PDAs. Whether the Bay Area grows slowly or quickly, the PDA development framework was effective in focusing the region's growth.
- **The trend is toward PDA-focused growth.** In 2013, just over a quarter of existing homes were located in PDAs. In 2018, over two-thirds of all housing permits were issued in PDAs, marking a clear trajectory toward successful integration of regional and local growth strategies.

CONS

- **The strategy does not equitably distribute responsibility for solving the Bay Area's housing crisis**[US]. The more constrained growth footprint studied in Futures Round 1 concentrated intense growth, with just five PDAs in San Francisco, Oakland and San Jose attracting 20% of all growth. A larger growth footprint, like the one studied in Futures Round 2, spreads development more evenly throughout the Bay Area without creating intense pressures on relatively small geographies.
- **The existing set of PDAs omits some areas that would support equitable and sustainable outcomes**. The voluntary local nomination process for PDAs misses some areas that provide access to high-quality transit service and/or higher economic opportunities. The most recent set of new PDAs submitted in 2019 begin to address these issues, but many of these critical areas remain undesignated.

Figure 17. Location of households added between 2015 to 2050 relative to Priority Development Area geography

TECHNICAL NOTES

To better understand this strategy's pros and cons, **the UrbanSim 1.5 land use model** was used to simulate the strategy. In Round 1, the land uses were defined by Plan Bay Area 2040 PDA geographies — adjusting zoning to allow for higher densities. In Round 2, PDAs were replaced by the "Allow Higher Densities Around All Transit Stops" and "Allow Higher Densities in High Resource Areas" strategies. Most PDAs are within these new boundaries, which is why substantial growth still occurred within existing PDA boundaries.

Allow a Greater Mix of Housing Types and Densities Around All Major Transit Stops

RATING ●●○○

CHALLENGE

Nearly 50% of areas within a half-mile of regional rail stations, ferry terminals and rapid bus stops have not been designated PDAs, despite meeting eligibility criteria. Because Futures Round 1 only prioritized existing PDAs, many Transit Rich Areas were not prioritized for development. Development occurring farther from transit may increase auto mode share, traffic congestion and GHG emissions.

STRATEGY

Expand the geographic footprint for areas beyond existing PDAs to allow a diverse range of housing within a half-mile (an approximately 10-minute walk) of all rail stations, ferry terminals and bus stops with 15-minute peak-period service — places eligible for designation as transit-rich PDAs. Areas surrounding new rail and bus rapid transit as part of new transportation strategies were also included.

RATING: Recommended to move forward with minor adjustments

The strategy was very successful in attracting a greater share of growth to areas with access to convenient transit. While locating new homes and jobs around transit has been shown to reduce per capita auto trips, this growth's magnitude of greenhouse gas reduction and equity benefits varies significantly based upon home affordability and the companion transportation strategies included. This strategy will need to be thoughtfully tailored to ensure greater levels of auto-trip reduction and improved synergies with other housing strategies such as the assignment of higher allowable densities in High Resource Areas as well as inclusionary zoning.

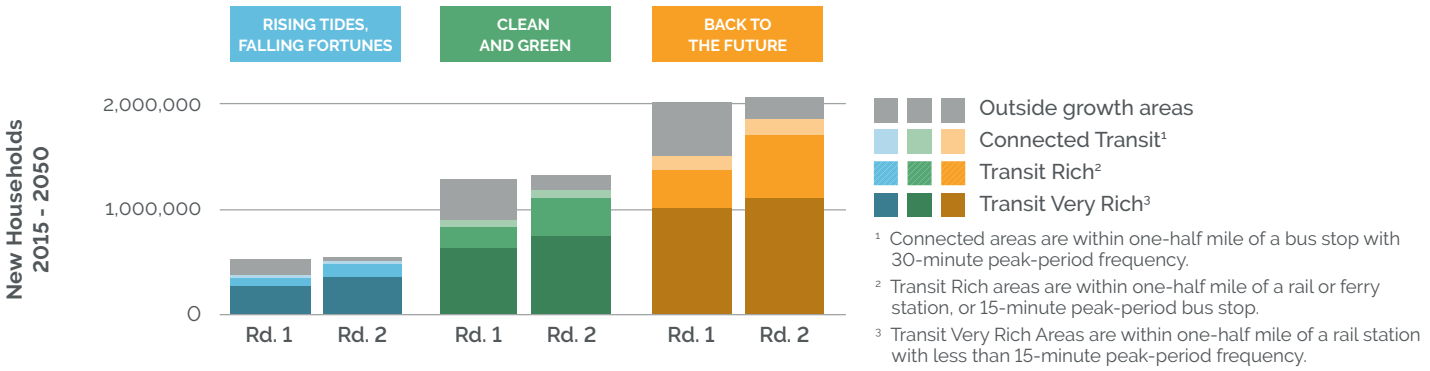
PROS

- **The expanded footprint increased transit-rich development by roughly 20 percentage points**[US]. Between Futures Round 1 and Round 2, growth near high-quality transit went from a 66% to 75% share of new growth to over 90% in all three Futures.
- **Placing growth near transit provides residents with expanded mobility options.** Compared with growth farther from transit, where transit accessibility is very limited, transit-adjacent growth offers greater choice.

CONS

- **Including non-locally nominated areas reduces the likelihood of implementation success.** Futures Round 2 asserted all Transit Rich Areas as areas for growth, but in many cases this is inconsistent with local plans at the current time. The local nomination process to date has helped align local and regional plans, helping participating jurisdictions implement at the local level.
- **Growing in Transit Rich Areas by itself may not drive desired outcomes**[32,33]. Many Transit Rich Areas had high rates of per-capita VMT in 2050, particularly those that remained lower density. Coupling this strategy with transportation and anti-displacement strategies is critical to ensuring a net regional benefit[TM,US].

Figure 18. Location of households added between 2015 to 2050 relative to transit growth geography



TECHNICAL NOTES

To better understand this strategy's pros and cons, **the UrbanSim 1.5 land use model and Travel Model 1.5** were used to simulate the strategy as part of a package. For many areas already designated PDAs, particularly those with recently adopted plans, this strategy involved little to no change, while in other areas it studied the effect of allowing a greater variety of housing at a higher density of development. Increases to specific density maximums varied based on transit frequency and capacity. Large areas eligible for PDA designation due to their access to transit include the Caltrain corridor, western San Francisco, and some BART and SMART rail stations. A companion literature review supported transit-oriented development effectiveness[34,35].

CHALLENGE

In the Bay Area, many areas with the highest quality schools, greatest job access and cleanest air have historically excluded low-income households, particularly people of color[36]. Among the Bay Area's High Resource Areas[37] eligible for PDA designation, only a handful have been designated by local governments — compounding the inequitable access to opportunity between communities.

STRATEGY

This strategy increases the housing variety that can be built in PDA-eligible High Resource Areas (HRA). The strategy is applied to both "transit-rich" and "connected community" PDA-eligible areas that are High Resource Areas, with the allowable development calibrated to level of transit access.

RATING: Recommended to move forward with minor adjustments

Pursuing this strategy in all PDA-eligible, High Resource Areas would advance access to opportunity. The strategy and associated allowable densities in Transit Rich HRAs led to significant housing development; however, the lower allowable densities studied in Connected Communities did not lead to significant housing growth. The higher allowable densities in "transit-rich" areas may have absorbed much of the total growth, leading to less "connected community" growth as it coincided with HRAs. Future strategy alterations might consider approaches to increase the share of growth in High Resource, Connected Communities.

PROS

- **Across all three Futures, the strategy was effective in locating housing growth within HRAs near transit**[US]**.** Twenty percent to 30% of housing growth occurred in "transit-rich" HRAs, achieving two goals at once. Housing development around transit at all income levels benefits ridership and typically reduces vehicle miles traveled, with affordable housing having the greatest benefit[38].
- **Integrating HRAs increases access to opportunity, especially when aligned with robust development**[US]**.** This strategy was most effective in Back to the Future where the strategy resulted in over 100,000 additional households in High Resource Areas, a 6% increase from the Round 1 analysis. This strategy aligns with the "affirmatively furthering fair housing" Regional Housing Needs Allocation (RHNA) objective.

CON

- **Implementation obstacles may make it hard to realize the gains from this strategy.** This strategy may face opposition in jurisdictions that currently permit multifamily housing at a relatively slow rate. Well-crafted policies and supportive resources that support "missing middle" housing types may ensure balanced development in High Resource Areas.

Figure 19. Location of households added between 2015 to 2050 relative to High Resource Area growth geography

[1] High Resource Areas are defined by an HCD methodology that identifies areas with high access to opportunity.

[2] Connected areas are within one-half mile of a bus stop with 30-minute peak-period frequency.

[3] Transit Rich Areas are within one-half mile of a rail or ferry station, or 15-minute peak-period bus stop.

TECHNICAL NOTES

To better understand this strategy's pros and cons, **the UrbanSim 1.5 land use model** was used to simulate the strategy with the "Assign Higher Allowable Densities Near All Transit Stops." In Futures Round 2 analysis, High Resource Areas that were in transit-rich locations were allowed equal permitted densities to any transit-rich location. Transit Rich Areas are defined as locations within one-half mile of rail stations, ferry terminals or bus stops with 15-minute peak headways or better. In addition, Futures Round 2 assumes an increase in permitted densities for High Resource Areas with a "Connected" level of transit, defined as areas within one-half mile of bus service with 16- to 30-minute peak headways. Companion literature review supported the strategy description[39,40,41].

CHALLENGE

Cities and counties generally do not build housing or commercial buildings — private developers do. However, even with strong market demand, areas that provide regional benefits like reduced GHG emissions may not attract private development without local policies that support future growth.

STRATEGY

Apply a set of development streamlining measures in areas prioritized for growth. In Plan Bay Area 2040 and in both rounds of Futures analysis, assumed faster development approvals and reduced parking requirements were used to streamline growth in PDAs and other growth geographies, which increased their attractiveness for new development compared to other areas.

RATING: Recommended to move forward

The strategy was included in Plan Bay Area 2040. While new Priority Development Areas are locally nominated, the same incentives should be applied to support an expanded set of Plan Bay Area 2050 priority areas for growth.

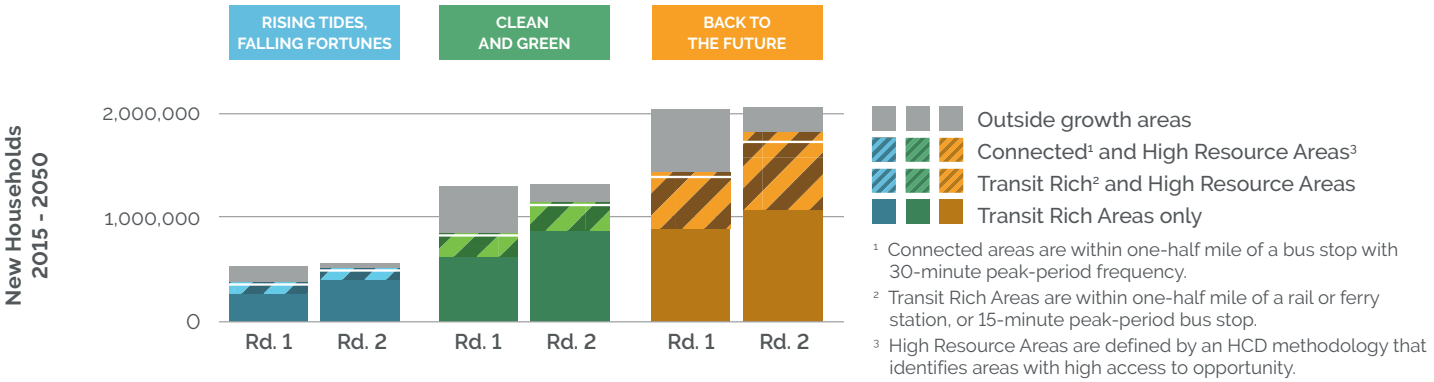
PROS

- **More than 90% of growth occurs within growth geographies in all three Futures**[US]. The streamlining measures coupled with the zoning changes in the previous suite of geography strategies create an attractive environment for growth regardless of different levels of development studied in different Futures. Model outputs illustrated below suggest that policies alone are enough to drive growth into priority areas.
- **Strategy uses policy rather than financial incentives to focus growth.** Using policy to focus growth rather than financial incentives are a cost-effective way to implement a land use blueprint.

CON

- **Streamlining needs to work for the community.** Streamlining that speeds project permitting can lead to missed opportunities to make the most of new developments. When done right, local land use planning that creates a framework for future development ensures new developments can proceed quickly, while meeting the community's priorities developed as part of a specific plan or general plan process.

Figure 20. Location of households added between 2015 to 2050 relative to growth geography



[1] Connected areas are within one-half mile of a bus stop with 30-minute peak-period frequency.

[2] Transit Rich Areas are within one-half mile of a rail or ferry station, or 15-minute peak-period bus stop.

[3] High Resource Areas are defined by an HCD methodology that identifies areas with high access to opportunity.

TECHNICAL NOTES

To better understand this strategy's pros and cons, **the UrbanSim 1.5 land use model** was used to simulate the strategy as part of a package. The model assumes that CEQA streamlining reflects a 1% more profitable development, reduced parking requirements reflect 1% more profitable development, and depending on a parcel's associated vehicle miles traveled, the development is 2% to -2% more/less profitable to reflect compliance with SB 743. The strategy also assumes that $40 million in Onw Bay Area Grant funding further improves overall profitability by the amount across all development within the growth geography.

CHALLENGE

The Bay Area's shortage of large development sites is another barrier to meeting the region's housing needs. Many housing sites prioritized by cities are small and more challenging to develop than large parcels with a single owner.

STRATEGY

Transform aging malls and office parks into mixed-income neighborhoods. Enable new land uses at these locations and support multi-benefit development goals with low-interest loans and predevelopment assistance for projects that meet affordability criteria in order to significantly reduce risk and development costs.

RATING: Recommended to move forward with minor adjustments

With a high volume of aging malls in Transit Rich Areas, the Bay Area should focus incentives in these areas first, particularly those in High Resource Areas. For malls and office parks not in transit-rich locations, it will be necessary to modify complementary transportation strategies to improve access to and from these potential redevelopment sites.

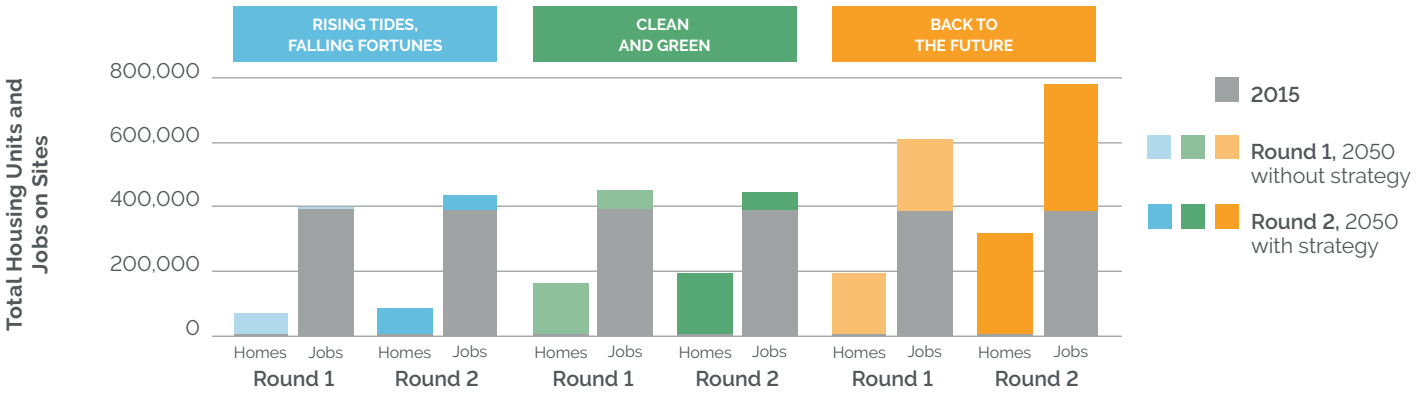
PROS

- **Redevelopment of large sites can help increase the scale and speed of delivering new housing.** A single redevelopment of a mall or an office park can deliver more homes than the gradual reuse of smaller parcels across an entire downtown or corridor. Figure 21 highlights the ability of these sites to add hundreds of thousands of new jobs and new homes[US].
- **Redevelopment can provide new benefits to surrounding community.** By rebuilding on vacant retail sites, no existing residents and small businesses are temporarily or permanently displaced. At the same time, sites that might otherwise remain derelict are brought to life by new local services and new residents that can support local businesses.

CONS

- **This strategy can often have uncertain development horizons.** The potential benefits of single ownership also create potential drawbacks, as some landowners may be unfamiliar or uncomfortable with the prospect of large mixed-use development, even as existing commercial uses decline.
- **Many viable mall and office park sites are not in Transit Rich Areas.** Although many sites included in this strategy are in Transit Rich Areas, realizing the full potential of this strategy would involve building in places that currently have limited transportation options, creating the potential for high rates of auto use without the application of significant transportation strategies.

Figure 21. Number of homes and jobs on aging malls and office parks



TECHNICAL NOTES

To better understand this strategy's pros and cons, **the UrbanSim 1.5 land use model** was used to simulate the strategy, both individually and as part of a package. The zoning at the sites was adjusted to allow for a greater diversity of housing uses as well as continued retail and commercial development. The land use, density and share of affordable housing of individual sites were based upon transit access and proximity to High Resource Areas. The sites were identified using 2018 CoStar data on commercial properties, which identified older and higher vacancy properties[42].

CHALLENGE

Bay Area land values are a major contributor to the high cost of developing housing. Higher development costs limit how far affordable housing subsidies go; these make market-rate housing more expensive.

STRATEGY

Leverage land owned by local governments and public agencies to build housing — particularly affordable or workforce housing. Allow housing to be built on 470 parcels (totaling 700 acres) identified by a 2018 MTC inventory of vacant and underutilized public land within one-quarter mile of transit.

RATING: Already moving forward due to state legislative action

These areas offer an opportunity for local governments to take a more active role in housing production. The strategy can be strengthened to leverage the value into greater development benefits, like requiring high rates of affordable housing as part of the future developments. AB 1486 was passed and signed into law in 2019, supporting this strategy.

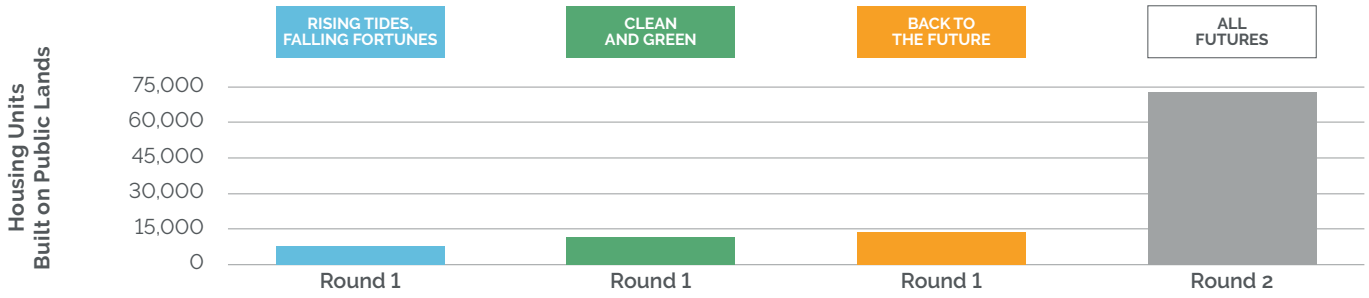
PROS

- **The sites could support over 70,000 new housing units**[OM]**.** Using a zoning code that allows for multifamily housing, the sites could represent a substantial share of development, ranging from 16% in Rising Tides, Falling Fortunes, 6% in Clean and Green, and just under 4% in Back to the Future.
- **Taking an active approach would advance development.** In Futures Round 1, some public land parcels were unavailable for development and some sites were passively available. Only 10% to 33% of these parcels developed with a passive approach in Round 1 analysis. Proactively zoning and selling the sites for development would result in faster and fuller action.

CON

- **There are competing uses for public land.** Underutilized spaces give agencies flexibility to use lands for temporary and future needs. Selling assets outright might limit future opportunities and flexibility.

Figure 22. Housing units built on underutilized public land near transit



TECHNICAL NOTES

To better understand this strategy's pros and cons, an off-model approach was developed and then applied to **UrbanSim 1.5 land use model** to simulate the strategy, both individually and as part of a package. Strategy implementation relied heavily on research developed in the 2018 MTC report **Public Lands Affordable Housing Action Plan**. The report was published with a companion data set of 470 publicly owned parcels within one-quarter mile of high-frequency transit. In the Round 2 analysis, the 470 parcels had development asserted based on the parcel size.

CHALLENGE

In the first Futures analysis round, displacement risk persisted in the two high-growth Futures, with a significant increase in Clean and Green. Without proactive policies, some lower-income households face displacement risk sometimes associated with growth and change.

STRATEGY

Implement renter protections that includes: (i) just cause evictions, (ii) anti-gouging cap, (iii) right to legal counsel and (iv) no net loss. A region-wide initiative would likely require roughly $90 million annually to implement, depending on the Future[43].

RATING: Already moving forward due to state legislative action

In October 2019, Governor Newsom signed AB 1482 into law, which included just cause eviction and an anti-gouging cap. Our analysis suggests that this strategy may not lead to significant long-term benefits over a 30-year planning horizon but may be a more effective short-term strategy to provide stability during an acute housing crisis.

PROS

- **The rental protections reduce displacement risk in the first five years of the studied period**[US]. Renter protections can help stabilize neighborhoods in the short term by preventing unwanted moves. Over time though, households will move for other reasons, and the policy does not ensure a low-income household will replace a low-income household that chooses to relocate.
- **At the macro scale, rent-controlled units may delay rental costs.** Over 30 years rent control will not slow rental housing's cost as a whole as rents reset to the market when new tenants move in; however, assuming the average rental unit has a tenant move in every five years[44], rent costs may be delayed by five years. In 2050 this means the average rental unit may rent at a 2045 rate.

CONS

- **The rental protections result in negligible impacts in terms of displacement risk through 2050**[US]. When looking to 2050, the protections do not alter the longer-term trends seen in Futures Round 1. While rental protections can help specific individuals, particularly when considering a shorter time horizon, longer-term benefits to displacement risk and affordability are less visible from renter protections.
- **This strategy, and the policies included within, do not ensure units maintain affordability in the long run.** Today, the average Bay Area household moves roughly every five years. This strategy may reduce this frequency slightly, but over a 30-year period the average household would still move five times (versus six under historical trends). With each move, a unit's affordability resets to current market conditions, washing away short-term benefits when studying long-term impacts.

First Five Years

0.5 - 2.1%

Reduction in Displacement Risk[US]

Over 30 Years

0.2 - 1.0%

Reduction in Displacement Risk[US]

TECHNICAL NOTES

To better understand this strategy's pros and cons, **the UrbanSim 1.5 land use model** was used to simulate the strategy, both individually and as part of a package. The results described above are from the individual strategy analysis. Renter protections are difficult to model, but to reflect their benefits, staff reduced the rate at which lower-income households move to reflect fewer evictions and more support for tenants to stay in their homes. The goal of this modeling approach is to decrease the rate that lower-income households move, meaning they can benefit from non-market-rate rents for a longer time period.

CHALLENGE

In both Plan Bay Area 2040 and in the Futures Round 1 analysis, housing affordability worsened in future years, with lower-income households experiencing the highest rates of cost-burden.

STRATEGY

Raise $1.5 billion in new annual revenues to complement existing federal, state and local affordable housing funds to preserve existing affordable units and construct new affordable housing units at a more aggressive pace.

RATING: Recommended to move forward with minor adjustments

There is broad agreement within the Bay Area that new revenues are needed for affordable housing. An additional $1.5 billion makes a sizeable dent in the need, but even more actions are needed to achieve the Horizon Guiding Principles. The Bay Area should explore how raising additional local resources could be leveraged to increase state and/or federal resources to the Bay Area and also continue to understand the impacts of raising this level of new revenue.

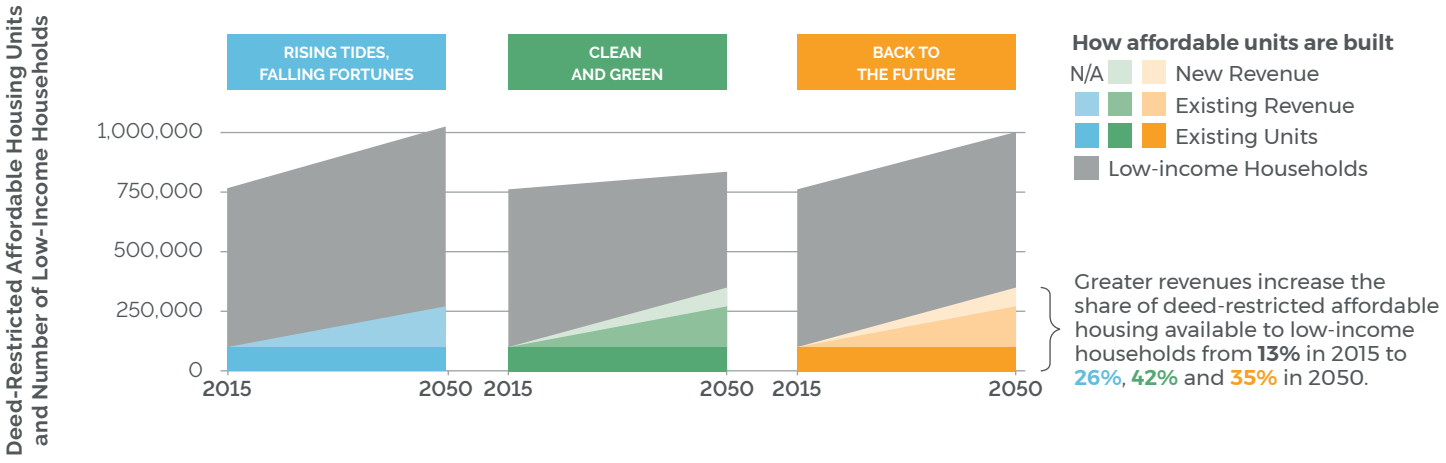
PROS

- **New revenues result in the preservation and production of 80,000 affordable units over 30 years**[OM]. These new units represent 4% and 7% of all units built in Back to the Future and Clean and Green. The added deed-restricted units are shown in Figure 23, reducing the affordable housing gap faster. The added revenue was not studied in Rising Tides, Falling Fortunes because of the high cost associated with this strategy.
- **Cities would have more revenue to meet affordable housing goals**[OM]**.** Any future revenues developed as a result of AB 1487, passed by the California Legislature in 2019, would direct the majority of funds to counties and cities to support local efforts to reach affordable housing targets.

CONS

- **Local funds would have to contribute a greater share of the per-unit subsidy.** The cost to build one affordable housing unit ranges from $450,000 to $700,000 in the Bay Area. This strategy adds additional local funds but does not increase state and federal funds. Without new matching funds, the local contribution to build one affordable unit would rise from $150,000 today to $200,000.
- **Raising revenue for affordable housing may be a significant challenge.** Raising $1.5 billion in new annual revenue would require broad support, particularly if the economy does not remain as strong as it is today. Strong region-wide partnerships would be necessary to build a coalition to support a measure of this scale.

Figure 23. Effect of additional revenue for deed-restricted affordable housing development, 2015 to 2050



TECHNICAL NOTES

To better understand this strategy's pros and cons, an off-model approach was developed and then applied to **UrbanSim 1.5 land use model** to simulate the strategy, both individually and as part of a package. Before plugging in revenue for affordable housing production and preservation into UrbanSim 1.5, staff consulted local experts to estimate the amount of revenue needed to preserve existing at-risk units. With remaining funds, staff estimated how new local revenue could be integrated with existing revenue sources to produce new units.

CHALLENGE

Despite an assumed 10% inclusionary rate in cities with PDAs in the Round 1 analysis, the Bay Area continued to see a sizeable gap between deed-restricted affordable units and the number of low-income households.

STRATEGY

Expand the Plan Bay Area 2040 strategy of 10% inclusionary zoning in jurisdictions with PDAs to a variable rate ranging between 10% in weaker-market communities and 20% in stronger-market communities.

RATING: Recommended to move forward with minor adjustments

Already a policy in 73 jurisdictions[45], inclusionary zoning is a powerful affordability strategy. To be effective, it requires market-rate growth to occur as well, and the inclusionary rate needs to be sized so as not to restrain the development market entirely. Continuing to refine appropriate rates across jurisdictions as well as for special sites like public lands will help address possible downsides and maximize the positive benefits.

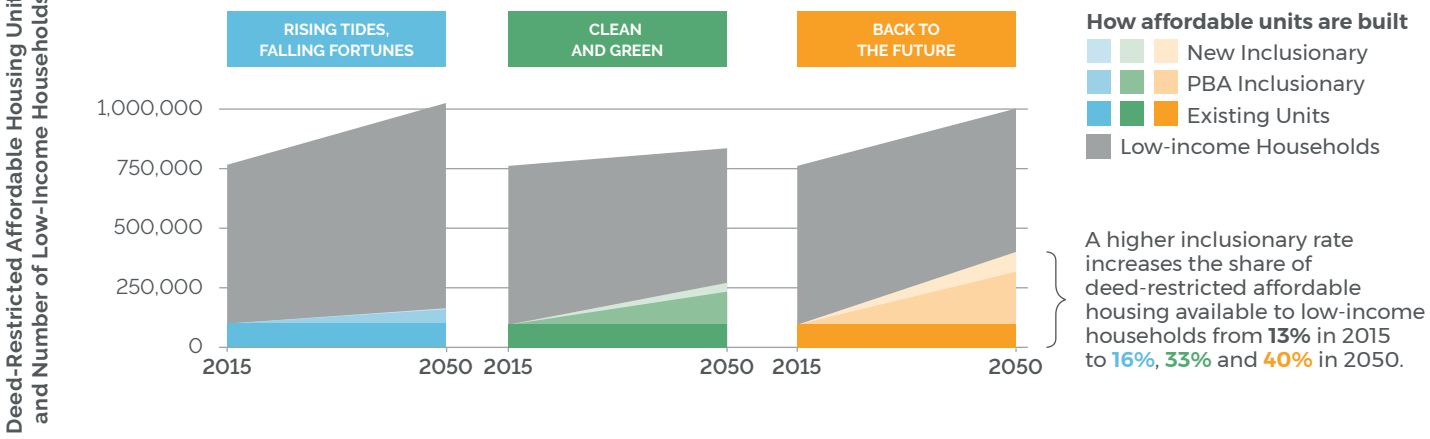
PROS

- **Up to 15% of all new development would be built affordable**[US]. Inclusionary zoning was responsible for 66,000 to 300,000 new deed-restricted affordable units across the three Futures. The wide range is a result of slow and fast growth futures — the policy generates many more units when the Bay Area is growing overall.
- **Inclusionary zoning does not require government subsidy.** Inclusionary strategies enable local governments to use land use authority to drive affordable housing production. By syncing inclusionary policies with density bonuses, affordable units are more easily generated by the private market.

CONS

- **If the inclusionary rate is set too high, it may restrain housing production.** Many studies have shown no negative effects on overall housing production, but there is acknowledgment that unreasonable rates could reduce overall housing development[46]. Setting an appropriate rate requires consideration of the temporal economic cycles and the local real estate market.
- **Inclusionary zoning is less effective when market-rate development slows down**[US]. The slow overall growth in Rising Tides, Falling Fortunes led to only 66,000 new affordable units[US]. Effective inclusionary zoning policy must be paired with strategies that also enable market-rate development.

Figure 24. Effect of inclusionary policy on deed-restricted affordable housing units, 2015 to 2050



TECHNICAL NOTES

To better understand this strategy's pros and cons, **the UrbanSim 1.5 land use model** was used to simulate the strategy, both individually and as part of a package. Using Redfin residential sales data from 2016–2018, jurisdictions were sorted into weaker (10% rate), moderate (15% rate) and stronger (20% rate) market bins. UrbanSim primarily illustrates the positive strategy effects, but the model has limitations related to the potential to restrain overall housing production. Additionally, the model ignores instances where a local jurisdiction may already have a rate greater than 10%, for example in San Francisco, which could lead to benefits being slightly over-estimated on the regional level. Companion literature review supported the strategy description[47,48].

Photo - Martin Klimek

TRANSPORTATION

Improve Access, Reliability and Speed of Transportation Services

This suite of strategies has the largest difference between Rising Tides, Falling Fortunes and the other two higher-growth, higher-resource Futures. Despite the additional funds from freeway pricing, funding remains tight in Rising Tides, Falling Fortunes — meaning that only low-cost strategies are proposed to be advanced alongside key investments from Plan Bay Area 2040, such as operating and maintaining the existing system. In addition to ushering in a next-generation transit network, the suite of upgrades also presents new opportunities for housing and job growth in transit-rich corridors. Refer to the Appendix for a list of investments included within each strategy.

- Operate and Maintain the Existing System
- Build Express Lanes and Address Interchange Bottlenecks
- Complete Set of Plan Bay Area 2040 Transit Expansion Projects
- Build and Operate an Express Bus Network
- Build a New Transbay Rail Crossing
- Modernize and Boost Frequencies to Create a Next-Generation Rail Network
- Extend the Regional Rail Network

Prioritize Active Modes

After receiving feedback from stakeholders in May 2019, staff significantly overhauled this strategy package to increase the level of planned investment and to incorporate a new strategy. Together, these three strategies — providing free, short trips (including via shared bicycles, scooters and shuttle service); reducing speeds to improve safety for all users; and building a transformative network of micromobility infrastructure — are designed to improve the attractiveness of active transportation modes.

- Provide Free Shared Bike, Scooter and Shuttle Services
- Lower Speed Limits on Highways and Local Streets
- Build a Complete Micromobility Network

Price Transportation Services

These strategies would price transportation services to incentivize non-auto trips and reduce the cost barrier of transit for lower-income residents. To enable better decision-making based on the costs of different modes, a single platform application for the Bay Area would also be implemented to help residents navigate their travel options. Freeway tolls would not only help to shift travel behavior but also to fund associated transportation priorities, including free transit for lower-income households.

- Develop a Single Platform to Access and Pay for All Mobility Options
- Apply Tolls Based on Time of Day and Vehicle Occupancy on All Freeways
- Provide Free Transit to Lower-Income Riders

CHALLENGE

The Bay Area has over 40,000 lane miles of city streets and county roads as well as over 3,000 buses and 1,100 heavy and light rail vehicles. Maintaining, replacing and operating this transportation system requires constant and significant investment.

STRATEGY

Commit to operating and maintaining the Bay Area's roads and transit infrastructure, replacing infrastructure at the end of its useful life and keeping current services running over the next 30 years.

RATING: Recommended to move forward

This strategy continues to be in effect in all three Futures, reflecting the longstanding Bay Area commitment to "Fix It First." With additional revenues from tolls and tax increases in Futures Round 2, around 55% of the budget in the two higher-growth Futures is dedicated to operating and maintaining the existing system, while in Rising Tides, Falling Fortunes operations and maintenance consume roughly 80% of the budget. Due to the high costs of reaching a state of good repair for the Bay Area's roadway and transit infrastructure, this strategy continues to aim for maintaining current conditions, in line with the strategy from Plan Bay Area 2040.

PROS

- **Maintaining the existing system is one of the most cost-effective investments.** Based on prior work from Plan Bay Area 2040, the benefit-cost ratios for maintaining local streets, bus and rail assets, and highways ranged from 4 to nearly 50, indicating that monetized benefits were substantially higher than costs[49]. There are considerable needs to achieve a state of good repair for the Bay Area's roads and transit assets — 32% of all trains, buses, light rail vehicles and ferries have passed their useful life benchmark, and local streets have a "fair" Pavement Condition Index rating[50,51].
- **Operating within a state of good repair has several benefits.** Maintaining road assets in a state of good repair extends the lifespan of tires, allows for more efficient use of gasoline and lowers the frequency of required maintenance and repair, all of which reduce individual automobile operating costs[52]. Maintaining a state of good repair for transit assets reduces disruptions to service due to asset failure and therefore improves reliability[53].

CON

- **The cost to operate and maintain the existing system has escalated faster than the system has expanded.** Maintaining existing conditions on the Bay Area's freeways, local streets and roads, bridges, and transit systems costs millions of dollars each year. Operating transit is particularly expensive, constituting roughly half of the total cost of operating and maintaining the existing system between now and 2050 in each of the three futures. Continuing to provide baseline transit service throughout the Bay Area, including in lower-density, higher cost per passenger areas without raising fares, will become more difficult over time if cost-saving measures are not implemented.

TECHNICAL NOTES

Baseline conditions are held constant within **Travel Model 1.5** as an approximation of preventing degraded transit or road asset condition. The strategy description is also supported by literature review[54,55,56,57,58].

CHALLENGE

Congestion on the Bay Area's highway network continued to worsen in all three Futures, with the greatest challenges occurring in Back to the Future where cheap and mostly autonomous driving led to peak-period congestion on every Bay Area highway by year 2050.

STRATEGY

This strategy integrates three separate highway-oriented strategies. First, add a limited set of new lanes and interchange improvements (as included in Plan Bay Area 2040). Second, add new lanes or convert existing carpool lanes to create the Regional Express Lanes Network (as included in Plan Bay Area 2040). Third, convert existing lanes to fill express lane network gaps to serve existing and potential express bus services, discussed in further detail later in this chapter.

RATING: Significant revisions needed for inclusion

These projects were shown to increase vehicle miles traveled and greenhouse gas emissions from transportation, directly conflicting with climate goals. Other strategies — namely, road pricing — could achieve similar congestion relief goals without increasing emissions. However, this strategy raises equity concerns, as higher-income drivers benefit more from express lanes than lower-income individuals. Possible revisions to address these concerns could include a means-based toll on express lanes, additional incentives to encourage carpooling, or a policy of converting general-purpose lanes to express lanes, where possible, instead of increasing road capacity.

PROS

- **Express lanes help expand and connect the network of existing carpool lanes,** providing uninterrupted guideways for express bus service and incentivizing higher vehicle occupancy over time. As high-occupancy vehicle (HOV) lanes are converted to express lanes and HOV lane gaps filled, carpooling, vanpooling and riding the bus may become more attractive than increasingly slower trips in the general-purpose lanes or high tolls in the express lanes. Without express lanes, express buses will continue to be impinged by traffic congestion, making them less time-competitive with the automobile. At the same time, express lanes ensure that the Bay Area can maximize HOV lane capacity and offer a reliable trip when it really matters by allowing solo drivers the choice to pay to use the lanes. The benefit of a connected network of HOV lanes could be further enhanced by strategies targeted at increasing shared rides, from expanding express bus services to investing in complementary park-and-ride projects or additional carpool incentives.
- **Unlike carpool lanes, express lanes have a built-in technology backbone.** This helps monitor and manage lane performance for a reliable trip all day long (including during non-recurrent congestion) and deter unauthorized use of the lanes. Similarly, this technology could allow for increased carpool occupancy requirements gradually over time, and due to its FasTrak® account requirement, it could also help address equity concerns if policymakers embrace such a policy.

CONS

- **Express lanes and bottleneck reduction projects may induce new trips that were previously discouraged due to longer travel times**[TM-PP]**.** The reduced travel times achieved by this strategy's express lanes element led to a 1 to 2 percentage point increase in daily vehicle miles traveled. As such, this strategy is not in sync with greenhouse gas reduction aims of Senate Bill 375.
- **Without complementary strategies, express lanes may fail to attract a greater share of carpoolers**[TM-MP]**.** With the full Express Lanes network in place, the projected share of vehicle trips that are carpools remains roughly constant at about 13% with three or more occupants and 16% with two occupants. Incentives like managed lanes to bypass traffic and reduced toll or toll-free passage may not be enough to encourage more carpools.

TECHNICAL NOTES

To better understand this strategy's pros and cons, staff used **MTC Travel Model 1.5** to simulate the strategy as part of a larger package of transportation projects and policies. The strategy builds off the set of express lane projects included in Plan Bay Area 2040, adding new segments to complete a fuller network to support the Express Bus Network strategy. The lanes were modeled as carpool lanes in Futures Round 2 as an occupancy-based and time-of-day-based tolling strategy was implemented concurrently; however, staff also integrated findings from Project Performance Assessment when developing this strategy summary, for which express lanes were studied independently with free access for HOVs and tolled access for single-occupancy vehicles.

Complete Set of Plan Bay Area 2040 Transit Expansion Projects

RATING ●●○○

CHALLENGE

In all three Futures Round 1 analyses, many of the Bay Area's transit systems had large overall trip demand increases, straining systems during peak-periods. The overcrowding challenge was most significant in Clean and Green, where other conditions led to the largest increase in the overall share of transit trips.

STRATEGY

This package of transit strategies includes all the major transit investments from Plan Bay Area 2040, including but not limited to BART to Silicon Valley Phase 2, Caltrain Downtown Extension, and Bus Rapid Transit (BRT) lines in San Francisco and the East Bay. It also includes congestion pricing zones in downtown San Francisco and Treasure Island that pay for associated transit frequency increases.

RATING: Recommended to move forward with minor adjustments

Many of these projects continued to perform well in the Plan Bay Area 2050 Project Performance Assessment process. For projects with less robust benefit-cost ratios, MTC staff should work with project sponsors to discuss possible project alterations or supportive policies that may improve project performance or consider removing select projects from the Blueprint.

PROS

- **Many of these projects have performed well in terms of cost-effectiveness and alignment with Guiding Principles**TM-PP**.** Investments like San Pablo BRT, BART Core Capacity and Geary BRT Phase 2 were among the highest-performing projects studied in Horizon. Such investments should be fast-tracked due to their resilience to future uncertainty in all three Futures.
- **These projects tend to be further along in preparatory studies, environmental review and plans for implementation.** Many of these projects could be implemented faster than projects of a similar complexity and scale that were analyzed for the first time through Horizon.

CONS

- **Benefit-cost analyses conducted for Project Performance suggest some Plan Bay Area 2040 projects are not likely to be resilient to future uncertainties.** Uncertain conditions in the Horizon futures resulted in lower benefit-cost ratios for some of these investments in the latest round of Project Performance Assessment. The majority of projects still had a benefit-cost ratio of one or more in at least one future, though several did not, suggesting that this list should be refined to advance the projects likely to be resilient to uncertainties.
- **Congestion pricing projects, which remain highly cost-effective, have equity shortcomings that should be addressed prior to inclusion in Plan Bay Area 2050**. Despite reinvestment of toll revenue into additional transit service, these projects require further consideration of equity strategies to ensure they do not disproportionately impact lower-income Bay Area residents by increasing travel costs to/from San Francisco.

TECHNICAL NOTES

To better understand this strategy's pros and cons, staff used **MTC Travel Model 1.5** to simulate the strategy as part of the Project Performance process. The project descriptions from Plan Bay Area 2040 were implemented within the larger Horizon package of transportation investments.

CHALLENGE

Today, 38% of Bay Area households live more than a mile away from a rail station. Connecting more Bay Area residents to rail is challenging with most remaining residents living in low-density locations that often do not have the ridership to support rail expansion.

STRATEGY

Create an expansive network of frequent and fast bus lines that operate outside of mixed traffic. Paired with the short-trip service discussed below — which addresses the last-mile problem for these corridors — this network would increase access to areas unserved by a fast and frequent transit option (e.g., I-680 corridor) and would offer capacity relief to key rail corridors (e.g., US-101 corridor).

RATING: Significant revisions needed for inclusion

Regional express buses, with bus priority treatments throughout the system, are a more affordable and adaptive option to rail. Providing an integrated and truly regional rapid bus network would provide greater transit access across the Bay Area. However, this project as studied in Horizon had many poorly performing lines and expensive capital investments, like tunnels. An approach starting with high-ridership lines might offer an incremental path forward. A region-wide strategy would require transit partners from across the Bay Area to redesign complementary rather than competing services to this strategy. Future adjustments would also need to address the equity concerns raised by the strategy.

PROS

- **By the year 2050, the regional express bus system would be the sixth busiest transit operator, surpassing SamTrans and Golden Gate™.** In Rising Tides, Falling Fortunes and Back to the Future, there are projected to be 200,000 daily boardings on the regional express bus network; in Clean and Green there are just under 300,000. The regional express bus system's success did in part draw riders away from existing transit services; existing express bus boardings decrease by 25,000 to 45,000 per day across the three Futures.
- **High ridership express bus stations tend to be located near regional rail, providing extra capacity to alleviate rail overcrowding™.** Across the three Futures, the stations with the highest boardings tend to be located at or within walking distance of other regional transit service.

CONS

- **Ridership on the regional express bus system was less robust in the South Bay™.** Across Futures, routes connecting the South Bay through hubs like Diridon, Mountain View and Palo Alto serve half to one-third as many riders as routes connecting the East Bay with San Francisco and the Peninsula. The only high ridership Silicon Valley route was Palo Alto to Berkeley. Meanwhile, Caltrain continued to operate over capacity, suggesting riders are opting for crowded rail conditions over rapid bus service.
- **Riders tend to be higher-income commuters traveling to job centers in San Francisco™.** Horizon Project Performance analysis suggested that the top 50% of earners received greater per-rider accessibility benefits than the bottom 50% of earners. The regional express bus system tends to attract office workers commuting to the West Bay, while local-serving BRT projects in San Francisco and the East Bay tended to attract a larger share of low-income riders.

Figure 25. Stations with the most regional express morning boardings in Futures Round 2 Analysis (Rank (AM Boarding))

REX STATION	AVERAGE ACROSS ALL FUTURES	RISING TIDES, FALLING FORTUNES	CLEAN AND GREEN	BACK TO THE FUTURE
Oakland (MacArthur)	**1** (4,900)	**2** (3,500)	**1** (6,900)	**2** (4,200)
Oakland (Coliseum)	**2** (4,200)	– (2,400)	**3** (5,600)	**1** (4,500)
Oakland (Mosswood)	**3** (4,000)	**1** (4,400)	**5** (4,800)	**4** (2,700)
El Cerrito (del Norte)	**4** (3,800)	**3** (3,000)	**2** (5,700)	**5** (2,700)
San Rafael (Downtown)	**5** (3,500)	**4** (2,900)	– (4,800)	– (2,700)
Berkeley (Downtown)	– (3,400)	– (1,900)	**4** (5,000)	**3** (3,300)
Vallejo (Ferry Terminal)	– (1,900)	**5** (2,400)	– (2,200)	– (1,100)

Dash marks are non-top 5 routes for that future

TECHNICAL NOTES

To better understand this strategy's pros and cons, staff used **Travel Model 1.5** to simulate the strategy as part of a larger package of transportation projects and policies. This strategy was not run in isolation for Futures analysis, but a larger scale version including 13 express routes, dozens of local feeder routes and new dedicated right-of-way on a number of congested local streets was analyzed individually via Project Performance. In the Futures Round 2 package, a network of 13 express bus routes that operate on freeways in a shared HOV/bus lane at five-minute peak headways was modeled.

CHALLENGE

By 2050, the existing BART Transbay Tube was over capacity in all three Futures, even with the set of capacity-increasing projects that were prioritized in Plan Bay Area 2040. Capacity constraints were greatest in Clean and Green, where there were nearly 75,000 overcapacity westbound morning trips.

STRATEGY

This strategy invests in a new transbay rail crossing, associated infrastructure improvements in the West Bay and East Bay, and frequency boosts on the rail system. While Horizon Perspective Paper 5 on Bay Crossings delved into the pros and cons of different options, staff used a second BART crossing as a placeholder to further study the potential synergies with housing and economic development from a crossing investment.

RATING: Recommended to move forward with minor adjustments

The crossing reduces congestion on the transbay corridor significantly and adds new transit-rich access points to the Bay Area. In addition to providing more frequency and access throughout the course of the day, the second line provides much-needed redundancy in the event of service disruptions. The inclusion of this specific BART crossing does not necessarily suggest that this crossing is the highest-performing option in the corridor. If the strategy moves forward, other studies will aid in the development of a final transbay crossing strategy. Further refinements will focus on how to include a new transbay rail crossing between San Francisco and the East Bay in the fiscally constrained Blueprint.

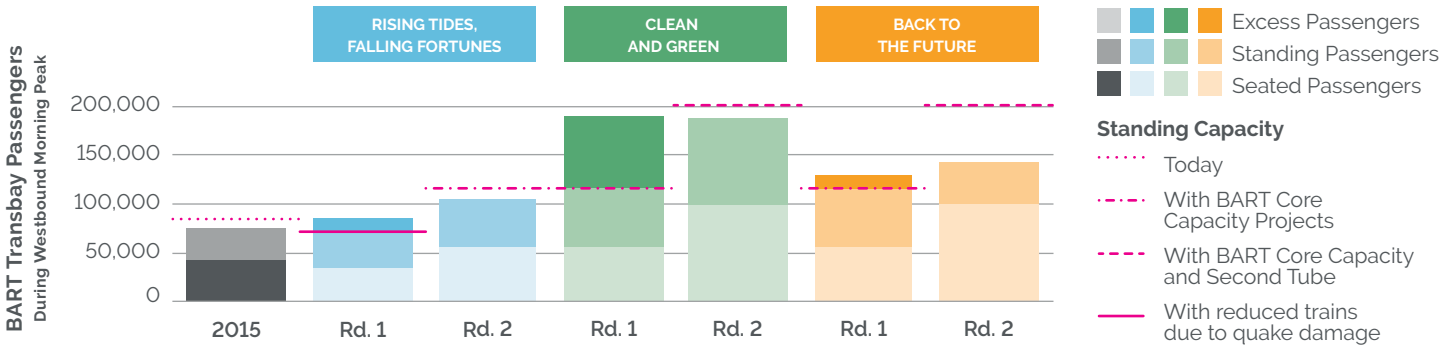
PROS

- **Congestion in the BART Transbay Tube in year 2050 is alleviated**[TM]. With a second crossing in place, BART transbay service meets all demand. Not only is crowding alleviated, improving rider experience, but the system also benefits from fewer delays due to the newly added redundancy.
- **Over 200,000 riders exit at new stations each morning**[TM]. The project assumes 15 new stations in San Francisco, Alameda and Oakland. An estimated 270,000 riders exit at these new stations each morning in Back to the Future, while an estimated 310,000 exit each morning in Clean and Green. This constitutes almost 30% of all AM peak-period exits in the Bay Area.

CONS

- **Without supportive land use changes, ridership will be less at new stations**[US]. Ridership at the new stations is roughly half that of existing San Francisco stations, even with strategic upzoning in Futures Round 2. Additional Priority Development Areas in station areas, whether in the East Bay or San Francisco, would help further strengthen this strategy.
- **This strategy is an expensive solution to the jobs-housing imbalance.** This strategy is a pricey solution to constrained capacity going westbound in the morning peak and eastbound in the evening peak; capital costs alone would add up to tens of billions of dollars. A new crossing enables a continued jobs-housing imbalance, instead of promoting strategies to better balance Bay Area housing and jobs.

Figure 26. BART transbay ridership during westbound morning peak



TECHNICAL NOTES

To better understand this strategy's pros and cons, staff used **MTC Travel Model 1.5** to simulate the strategy as part of a larger package of transportation projects and policies. A new BART line operating between MacArthur and Daly City was introduced into the model. Related projects in Futures Round 2 include BART Core Capacity frequency and capacity increases and BART to Silicon Valley Phase 2, which integrates service to Downtown San Jose and Santa Clara.

CHALLENGE

Existing rail service operates using technology and equipment that in some cases are decades old and that only meet a fraction of the forecasted future travel demand. The legacy and aging infrastructure reduces reliability and on-time rates. Many existing rail corridors can support additional capacity but require new investments like additional train cars.

STRATEGY

This strategy seeks to provide crowding relief on systems that are overcapacity by year 2050. Investments in a next-generation set of improvements to the Caltrain corridor enable even more frequent service; grade separation of VTA light rail allows for frequent automated service between communities identified for growth. In San Francisco, this strategy funds the Muni Southwest Subway that allows for more frequent and reliable service between the Financial District and Parkmerced.

RATING: Significant revisions needed for inclusion

Despite billions of dollars of investment in projects to address constrained capacity on the Bay Area's rail systems, the projects in this strategy did not significantly mitigate overcrowded conditions; however, the most strategic and effective projects to complete a seamless network could be identified to move forward. These projects may be more effective if paired with supportive land use strategies to address the spatial imbalance of jobs and housing, potentially making use of existing excess capacity in the reverse commute direction.

PRO

- **Increased system capacity alleviates overcrowding and improves passenger experience.** In Futures Round 1 analysis with only Plan Bay Area 2040 strategies in place, systems like VTA light rail, Caltrain and BART were overcapacity by the year 2050. With this strategy in place, fewer sections of transit are overcapacity and many more passengers have seated rather than standing trips™. Also, by replacing old equipment, disruptions are reduced and reliability is improved, a crucial characteristic in attracting and retaining passengers[59,60].

CONS

- **Relatively few people switch to transit with this strategy in place.** This strategy intended to make transit a more attractive alternative by reducing travel times and decreasing crowding. However, these modifications did not meaningfully increase transit mode share. Between Futures Round 1 and Round 2, transit commute share increased by less than one percentage point. However, the model does not capture mode shift they may occur from improved reliability described in the Pro column.
- **With transformed South Bay land use, extensive rail modernization efforts on VTA light rail fail to fully meet demand.** This strategy intended to make transit a more attractive alternative by reducing travel times and decreasing crowding. However, these modifications did not meaningfully increase transit mode share. Between Futures Round 1 and Round 2, transit commute share increased by less than one percentage point. However, the model does not capture mode shift that may occur from improved reliability described in the Pro column.

TECHNICAL NOTES

To better understand this strategy's pros and cons, staff used **MTC Travel Model 1.5** to simulate the strategy as part of a larger package of transportation projects and policies. Modifications to existing service were made based on project submissions, including changes to travel time between stations for grade separation projects and increases in frequencies for modernization projects. **Literature review** on the effect of transit reliability and other improvements also supported the strategy findings[61,62].

CHALLENGE

Many Bay Area cities and towns are not served by regional rail, which limits accessibility for residents and workers and could be contributing to increased auto usage and traffic congestion.

STRATEGY

This strategy supplements the planned rail expansion detailed in Plan Bay Area 2040 with several new rail projects. New extensions connect SMART to the BART system across a rebuilt Richmond-San Rafael Bridge, while Dumbarton Rail improves connectivity between BART and Caltrain in the South Bay. Extensions to Healdsburg, Brentwood, Livermore and beyond would connect communities without access today.

RATING: Significant revisions needed for inclusion

Extending rail into new markets is an attractive but expensive way to continue to expand transit connectivity. With many of the highest density communities connected by rail, many expansions into lower-density communities do not have the associated land use to support the system. Two exceptions to this finding would be Valley Link and BART to Brentwood, the former of which performed well thanks to megaregional demand for rail access and the latter of which would connect to newly proposed Priority Development Areas (PDAs).

PRO

- **Seventy-five thousand to 88,000 more households have access to a rail station within 1 mile of their homes**[US]**.** The synergistic policies of extending rail and allowing for higher-density housing near stations result in an increase in households living within 1 mile of a rail station. This is particularly impactful for those without access to a car, greatly improving their levels of access to the Bay Area's resources. This statistic would be even higher in data on megaregional commuters served by Valley Link, in particular.

CONS

- **Relatively few people switch to transit with this strategy in place.** This strategy intended to make transit a more attractive alternative by reducing travel times and decreasing crowding. However, these modifications did not meaningfully increase transit mode share. Between Futures Round 1 and Round 2, transit commute share increased by less than one percentage point. However, the model does not capture mode shift they may occur from improved reliability described in Pro column.
- **Large-scale transit expansion investments fail to move the needle on transit mode share.** Seventeen percent to 19% of all commuters took transit across the three Futures in Round 1[TM]. In Round 2, after applying a large package of transit and active transportation strategies, the projected share of transit commute mode share increased by 1% or less above the Round 1 modeling.

TECHNICAL NOTES

To better understand this strategy's pros and cons, staff used **MTC Travel Model 1.5** to simulate the strategy as part of a larger package of transportation projects and policies. New rail lines were added to represent extensions of existing service or the creation of new rail lines. The results of this strategy include the effects of the companion land use strategy, "Allow Higher-Density Housing Near All Transit Stops."

CHALLENGE

Many Bay Area's roads and transit lines are congested during commute hours today, with these conditions worsening in the Round 1 analysis of each Future. According to travel model forecasts of the 2015 base year, 47% of all Bay Area trips were under 3 miles.

STRATEGY

This strategy provides free shared personal mobility (e.g., scooters and electric bicycles) for short trips within 3 miles of the areas prioritized for growth in Futures Round 2. Understanding that those with limited mobility may not be able to take full advantage of these services, autonomous shared shuttles would provide similar service within this same geography.

RATING: Significant revisions needed for inclusion

Over the past few years, many Bay Area cities have dealt with the growing pains of new personal mobility options. As personal mobility options continue to evolve to offer easier, faster and safer options, the Bay Area can consider methods to make them accessible to all residents by exploring the opportunities of shared mobility. However, the sheer cost of this strategy means that it needs to be further refined to focus on lower-income populations — who stand to benefit the most from reduced travel costs — and in geographies that are most supportive of non-motorized modes.

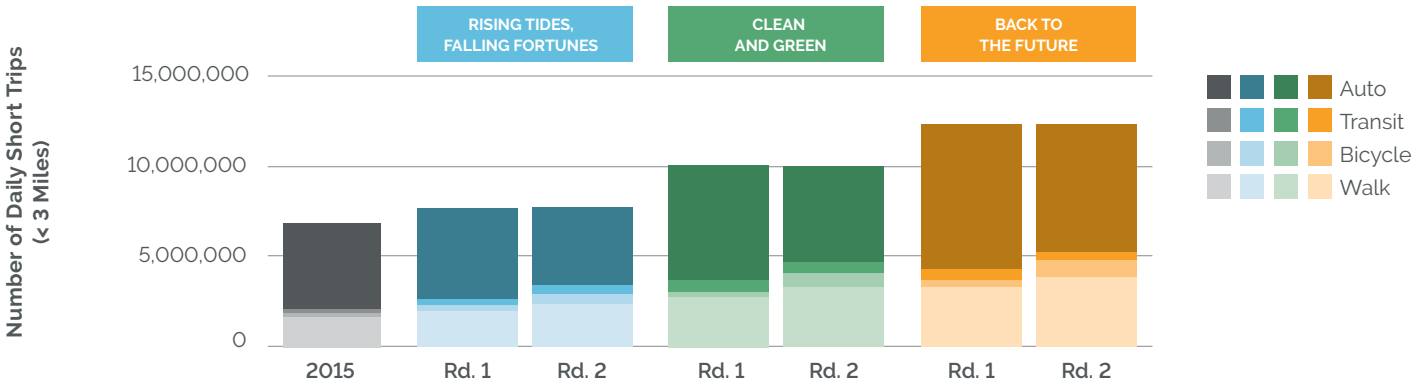
PROS

- **Shared scooters and e-bikes enable slightly longer trips.** The average walking trip in 2015 was just under 1 mile and the average bike trip was 2.2 miles. In the Round 1 analysis these trip lengths remained roughly constant. In Round 2, electric-powered options were assumed to be faster, leading to a 0.1 to 0.25 mile increase in the average walk and bike trip. While not drastic, it does translate to increased accessibility.
- **A larger share of residents walk or bike for short trips.** In 2015, bike trips accounted for 3% of trips under 3 miles, while walk trips accounted for 24% of such trips. Futures Round 1 analysis projected these shares to increase slightly by 2050 with only Plan Bay Area 2040 policies in place. With this strategy in place, the share of biking short trips doubles, reaching 7% or 8% of all short trips. Walk trips, meanwhile, increased by 5 percentage points in each future, reaching one-third of all trips under 3 miles.

CON

- **Maintaining a fleet of free shared scooters and bikes will be costly.** Currently, venture capital-backed businesses subsidize shared scooters and bicycles. The Bay Wheels membership rate was originally priced to cost of $150 per person per year. Further research estimates that memberships could be subsidized by as much as $900 per participant, escalating costs up to six times higher than initial estimates.

Figure 27. Mode share of all short trips (less than 3 miles)



TECHNICAL NOTES

To better understand this strategy's pros and cons, staff used **MTC Travel Model 1.5** to simulate the strategy as part of a larger package of transportation projects and policies. To approximate the increased availability of free e-bikes, staff updated effective average bike travel speeds from 12 mph to 15 mph. To approximate the increased availability of e-scooters, staff assumed a percentage of walk trips that would be likely to use e-scooters (12%). Scooters operate at a max speed of 15 mph, so staff increased the walk travel speed to reflect 12% of walkers using scooters at an average of 12 mph, raising the average walk speed from 3 mph to 4 mph.

CHALLENGE

Over 400 fatalities and 1,500 serious injuries occur on Bay Area roads each year[63,64]. Furthermore, as the population grows and total vehicle miles traveled increase, these numbers could be expected to rise if policies remain unchanged.

STRATEGY

Reduce local street speed limits in growth areas to 25 mph and reduce freeway and highway speed limits to no greater than 55 mph. The strategy assumes some costs to support enforcement and education.

RATING: Recommended to move forward with minor adjustments

Reducing speeds on both local roads and highways would save thousands of lives and prevent serious injuries over a 30-year period. On highways, the speed reduction would help curb emissions for internal combustion engine vehicles and provide a fast way to reduce emissions considerably. Developing an enforcement technique is crucial in getting buy-in that this strategy is implementable.

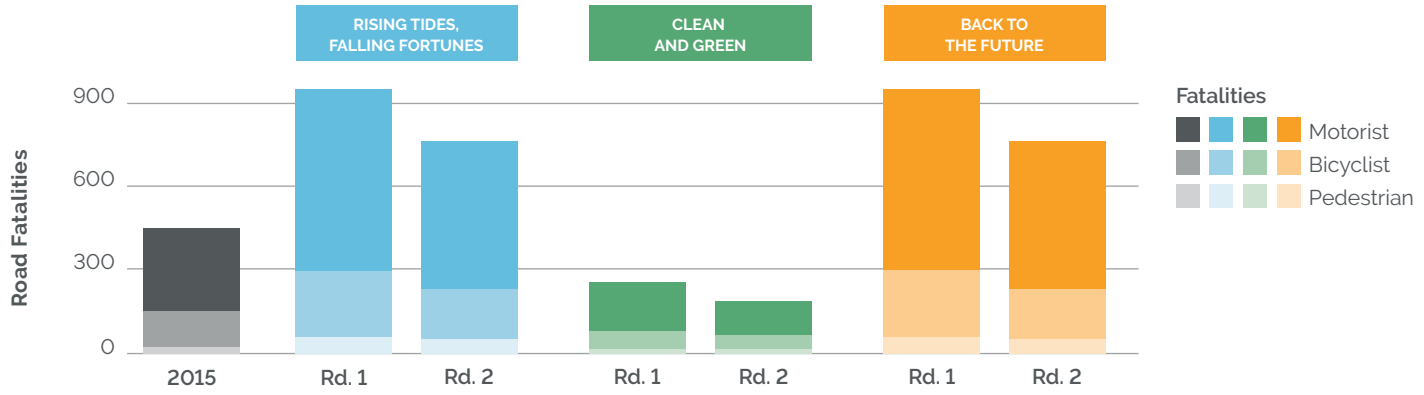
PROS

- **Lower travel speeds result in many fewer fatalities and serious injuries[OM,65,66].** The strategy is estimated to reduce annual on-road fatalities by 75 to 200 and decrease serious injuries by 175 to 500 per year. The lower speeds reduce deaths for all road users — motorists, pedestrians and cyclists. The strategy is effective even in Futures with higher levels of autonomous vehicle adoption.
- **Freeway greenhouse gas emissions decrease.** The most efficient, lowest-emission travel speeds for gas-fueled vehicles range from 40 to 45 mph, well below currently allowed freeway speeds[67,68]. Capping freeway speeds at 55 mph will make travel more efficient and reduce greenhouse gas emissions.

CONS

- **Enforcement may prove challenging.** Enforcing speed limits with traditional methods would require substantial labor hours from law enforcement; alternatively, a system of speed-tracking cameras could automatically issue tickets but requires changes to state law [69] and might raise privacy concerns. Both enforcement methods would become increasingly obsolete with an autonomous fleet.
- **Greenhouse gas emissions on local streets could increase.** Vehicle speeds between 40 and 45 mph are the least greenhouse gas emissions-intensive on average[70]. As such, reducing vehicle speeds on local streets to below 25 mph will result in slightly increased greenhouse gas emissions.

Figure 28. Annual road fatalities in 2050



TECHNICAL NOTES

To better understand this strategy's pros and cons, staff used **MTC Travel Model 1.5** to simulate the strategy as part of a larger package of transportation projects and policies. Maximum free-flow speeds on all freeways and expressways were set at 55 miles per hour. Maximum speeds on all other facilities within a 3-mile buffer of growth geographies were set at 25 miles per hour. This strategy's modeling assumed complete compliance with posted speed limits. Fatalities and serious injuries averted were calculated based on research on the relationship between average vehicle speeds and rates of fatality or serious injury[71,72]. The analysis and writeup was supported by additional literature review and MTC data sets[73,74,75,76,77].

CHALLENGE

Forty-seven percent of all trips in 2015 were under 3 miles (a 20-minute bike ride), yet bicycle trips accounted for just 2% of all trips. A 2015 survey of adult residents in large metro areas found that half of adults were "interested but concerned" when it came to cycling as a mode of transportation[78].

STRATEGY

Build out nearly 10,000 miles of new bicycle infrastructure, including Class IV protected bike lanes on arterials and thousands more miles of Class II bike lanes on lower-volume streets. Furthermore, the strategy completes the Bay Trail and builds a network of separated bike lanes parallel to freeway corridors.

RATING: Recommended to move forward

Every percentage point matters in reducing greenhouse gases and congestion on roadways and busy transit lines. The strategy is quick to implement and much cheaper than other transportation alternatives — protected bike lanes cost around $1 million per mile while off-street segments like the Bay Trail can cost $6 million per mile, both bargains compared to other modes. Given the low cost relative to other investments studied, the benefit-cost ratio is greater than one in all three Futures and the equity scores suggested that lower-income individuals received a larger share of accessibility benefits than higher-income individuals, meaning this strategy advances equity outcomes too.

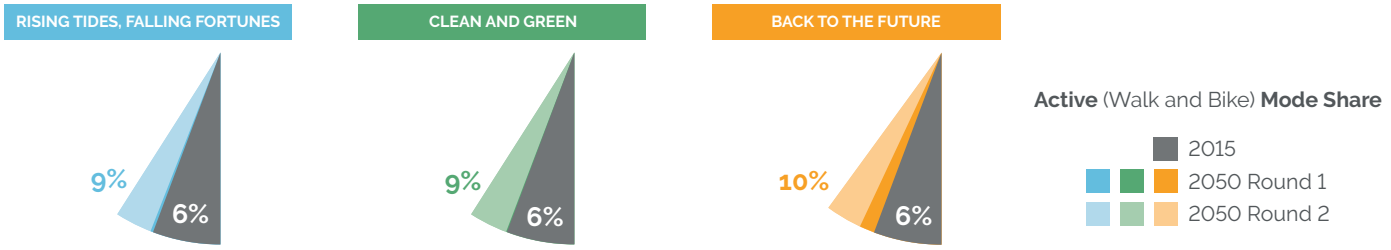
PROS

- **Micromobility infrastructure makes biking, walking or scootering more comfortable, safer and more attractive.** This strategy's proposed investment package would triple the density of bike infrastructure from 2015 to 2050. The share of commute trips by bike is expected to rise by 3% to 4% based on the bicycle infrastructure density this strategy would generate. There was no data on the relationship between infrastructure and scooter usage to inform a change in scooter trips.
- **The strategy has safety and health benefits.** By reducing the exposure of pedestrians, cyclists and scooter users to automobiles, there is lower likelihood of collision. Active modes, and the physical activity associated with them, lower rates of lifestyle diseases and improve overall public health[79].

CONS

- **This strategy only benefits those that already have access to a bicycle or scooter and the physical ability to participate in active modes.** This strategy does not benefit those that have physical limitations that preclude them from cycling, walking or scootering. It also does not expand bicycle or scooter access to residents without them.
- **Exposure to air pollutants from highways could adversely affect bicycle superhighway users.** Air pollution is often greatest immediately adjacent to freeways, as emissions are concentrated at these facilities. As such, cyclists traveling on bike superhighways immediately adjacent to freeways could run the risk of adverse health impacts due to exposure to air pollutants[80].

Figure 29. Active (walk and bike) commute mode share in 2015, and in 2050 Futures Round 1 and Round 2 analysis



TECHNICAL NOTES

To better understand this strategy's pros and cons, staff used **MTC Travel Model 1.5** to simulate the strategy as part of a larger package of transportation projects and policies. Bicycles were allowed on highways to represent the addition of bike superhighways (this includes the Bay Bridge West Span, which is also part of the Bay Trail). Other modeling inputs were supported by **literature review**[81,82,83]. The bicycle mode choice constants, which aggregate a number of descriptors of the attractiveness of that mode, were increased to make bicycling slightly more attractive, based on research on the relationship between density of miles of bike infrastructure per square mile and bicycle commute mode share at the city level. Researchers found that a 1 point increase in miles of bike infrastructure (Class I bike path, Class II bike lane or Class IV protected bike lane) per square miles of city land area was correlated with a 1 percentage point increase in bicycle commute mode share. The mode choice constant was increased to result in a roughly 3 percentage point increase in cycling, based on a change in miles of infrastructure density.

Develop a Single Platform to Access and Pay for All Mobility Options

RATING ●○○○

CHALLENGE

With over 20 transit operators and dozens of shared mobility services currently operating in the Bay Area, planning a trip and paying for it can be a complicated process that detracts from the user experience.

STRATEGY

Support the development and public adoption of a Mobility as a Service (MaaS) platform. These platforms, currently available through pilot programs in select cities, allow residents to plan trips and view all transportation options (e.g., transit, bike/scooter share, ridehailing) and pay for them using a fare payment card or smartphone. For the unbanked, an e-wallet application could enable platform access. The platform would also allow for incentives and information targeted toward different user types to encourage use of transportation alternatives.

RATING: Recommended to move forward

Mobility as a Service creates a platform for fare integration, incentive programs and real-time information dissemination. The strategy is likely to have a minimal cost compared to other strategies, can provide travel savings for a variety of modes and would be effective in all Futures.

PRO

- **Simplifying the user experience of taking transit or using shared modes could incentivize reduced levels of auto ownership and single-occupancy vehicle travel.** Evaluations of similarly designed pilot projects in Europe suggest that participants use personal automobiles less and would consider reducing their household's number of vehicles if the pilot project were to continue[84,85]. These findings are promising, but larger studies are needed to reliably quantify benefits.
- **Trip planning and fare-payment time savings could improve transit's operational efficiency.** Time savings of seconds and minutes when scaled across millions of transit boardings scales benefits. Additionally, MaaS-enabled transit payment can make transit faster and more reliable by enabling pre-paid trips and all-door boarding.

CONS

- **Presenting users with ridehailing or car share services could increase their usage and in turn, vehicle miles traveled and greenhouse gas emissions.** This strategy relies on offering users with all possible mobility options, including ridehailing and car share services. Presenting these options could make them more competitive to more sustainable modes like transit or shared bikes/scooters.
- **This strategy targets users with smartphones and bank cards, though provisions could be made for those without access to these resources.** A report from Pew Research Center stated that 81% of American adults had access to a smartphone[86]. That share is likely to increase over time as the cost of owning a smartphone continues to decrease. Eighty percent of American adults had access to a debit card in 2017, though disparities in access to credit along racial and socioeconomic lines do exist[87]. Cash-only users could be accommodated through partnerships that provide opportunities to reload accounts with cash; examples of potential partners include convenience stores, libraries and community centers.

TECHNICAL NOTES

To better understand this strategy's pros and cons, staff conducted a research literature review on the effects of previous Mobility as a Service (MaaS) efforts, including projects in Helsinki, Finland[88], and Vienna, Austria[89]. The benefits of the strategy within the Bay Area were qualitatively assessed based on observed outcomes detailed in the literature[90,91].

Apply Tolls Based on Time of Day and Vehicle Occupancy on All Freeways

RATING ●●○○

CHALLENGE

Congestion on the Bay Area's freeways is already a challenge; in the Futures Round 1 analysis it grew, particularly in Back to the Future where cheap driving and rapid growth led to gridlock. The assumed levels of electric vehicle adoption also led to reduced gas tax revenues in relevant Futures.

STRATEGY

Apply tolls to all freeway lanes. During peak-periods, rates would vary from 15 cents per mile for vehicles with two or fewer occupants to 5 cents per mile for 3 person carpools. During off-peak-periods, freeway rates would be 5 cents per mile. Bridge tolls would remain in effect, as would state taxes on gasoline and diesel. Funds from this road-user fee would be used to fund alternatives to driving.

RATING: Recommended to move forward with minor adjustments

Dynamically pricing highways is a method to reduce congestion, curb single-occupancy vehicle miles traveled and hedge gas tax revenue deficits. Both the financial and access impacts on lower-income residents and megaregional residents must be studied further and addressed to reduce the downsides of the regressive nature of tolls.

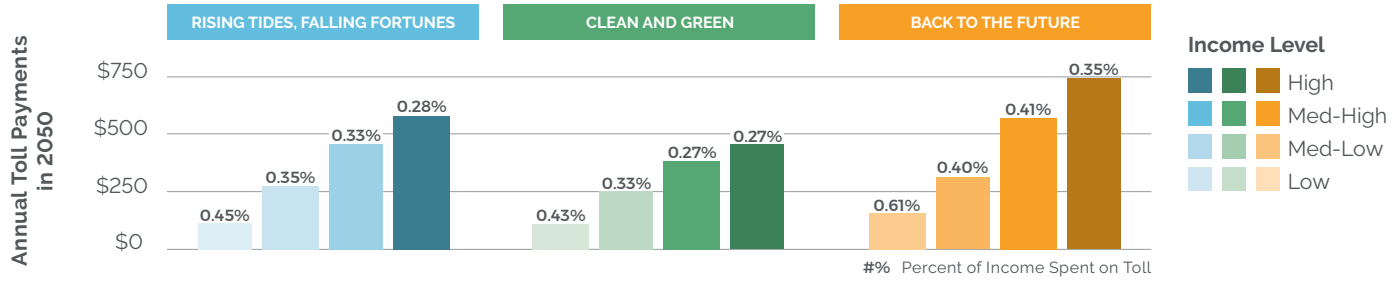
PROS

- **By 2050, the strategy is projected to generate between $1.8 and $3.2 billion per year in revenue, which can be reinvested in transportation alternatives.** By 2050, motorists log 190 million to 360 million vehicle miles per day, resulting in annual revenues ranging from $1.8 billion to $3.2 billion by the year 2050 (in 2019 dollars). In total, this strategy is projected to generate $40 billion in Rising Tides, Falling Fortunes, $40 billion in Clean and Green and $60 billion in Back to the Future.
- **The share of single-occupancy vehicle trips drops substantially.** In 2015, single-occupancy vehicle trips accounted for 47% of all trips, a share that stayed roughly constant in Round 1 analysis. In Round 2, the share of single-occupancy vehicle trips across all trips decreased by 4 to 6 percentage points, but the share of three or more occupant trips declined as well, suggesting that this strategy's carpooling discount component failed to encourage more carpooling.

CONS

- **Toll rates are applied uniformly, placing greater per-mile impacts on lower-income households.** Despite lower-income households on average contributing fewer dollars to tolls than higher-income households (see Figure 30), the impact would undoubtedly be felt more by lower-income households.
- **Drivers from outside of the Bay Area might pay a substantial share of tolls**. Drivers with an origin or destination outside the Bay Area paid just under 40% of all tolls, likely due to long trips and limited transit alternatives. Given the observed trends of lower-income Bay Area residents relocating outside the region while continuing to work within the region, this finding raises equity concerns.
- **Significant hurdles in federal and state policies may make it difficult to implement this strategy.** Not surprisingly, policy implementation would require significant changes in state and federal policies to enable the Bay Area to convert freeways to tollways. New infrastructure would be required to appropriately calculate point-to-point tolls while verifying vehicle occupancy traversing the Bay Area's freeways.

Figure 30. Annual toll revenue per household by income in 2050



TECHNICAL NOTES

To better understand this strategy's pros and cons, staff used **MTC Travel Model 1.5** to simulate the strategy as part of a larger package of transportation projects and policies. A toll was applied to all lanes on the entire freeway system: $0.15 per mile for travel during the peak-period with fewer than three occupants and $0.05 per mile for travel with three or more occupants during the peak or for non-peak travel at all vehicle occupancies.

CHALLENGE

Transportation is the second highest expense for the average American family after housing[92,93]. Furthermore, transportation expenditures for the bottom 20% of earners rose 6% between 2017 and 2018 across the U.S., an increase twice as large as any other income group[94].

STRATEGY

This strategy provided free transit for households earning less than the median income. Existing discounted fare programs (e.g., youth, students, senior, people with disabilities) would remain in effect. This strategy interfaces with the Mobility as a Service strategy to access and pay for all mobility options.

RATING: Significant revisions needed for inclusion

The annual savings for lower-income households as well as the increased lower-income transit ridership are desirable outcomes. To realize these benefits, a range of other strategies that would backfill lost fare revenue and ensure sufficient transit capacity would be required to meet new demand. MTC should continue to use the means-based fare pilot to explore the opportunities and challenges associated with this strategy, potentially considering an expanded fare discount as part of the Plan Bay Area 2050 Draft Blueprint.

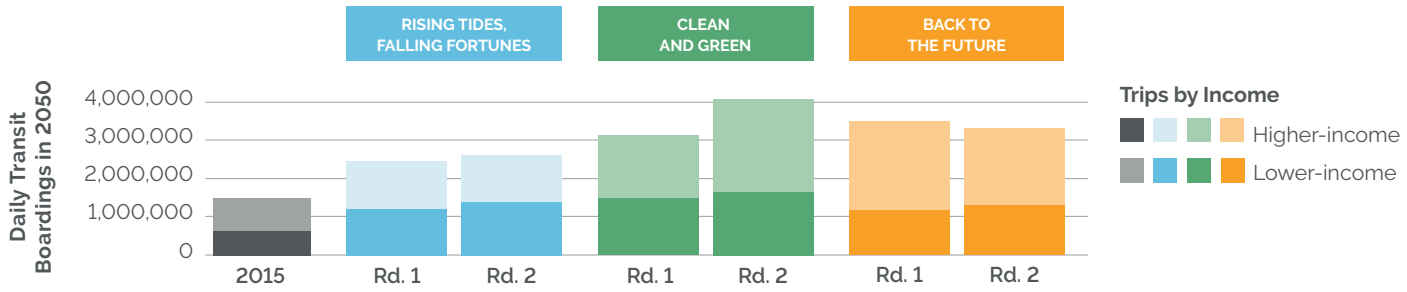
PROS

- **Travel costs decrease by 33 to 40% for lower-income individuals™.** In Futures Round 1, the lowest-income households paid $4 to $6 on auto and transit per day. Lower-income households save $640 per year in Back to the Future and $1,135 per year in Clean and Green in transit fares.
- **Transit trips by lower-income riders increase by 12% between Round 1 and Round 2 in Clean and Green and Back to the Future™.** This finding is particularly significant in Back to the Future, where overall transit boardings declined by 5% between Round 1 and Round 2.

CONS

- **Offering free public transit could exacerbate existing transit overcrowding issues and cause overcrowding on systems currently operating under capacity.** Without investments to improve capacity on overcrowded systems, reducing the financial barrier to taking transit would likely lead to an increase in transit usage, which could stretch already overburdened systems even further.
- **Cash-strapped transit operators would need a new subsidy to accommodate further reductions in fare revenue.** By 2050, lower-income riders are projected to pay $1.2 billion to $1.8 billion (in 2019 dollars) in fares in Back to the Future and Clean and Green respectively. This is 37% of all fares collected in Back to the Future and 40% of all fares for Clean and Green, leaving transit operators with a large financial deficit to fill[95].

Figure 31. Daily transit boardings by income level in 2050



TECHNICAL NOTES

To better understand this strategy's pros and cons, staff used **MTC Travel Model 1.5** to simulate the strategy as part of a larger package of transportation projects and policies. Transit fares for individuals in the lowest two income quantiles (with household incomes lower than $100,000 in today's dollars) were set to $0, with no other modifications to fares or service frequency made.

ENVIRONMENT

Reduce Our Impact on the Environment

The environment and resilience strategies were designed to continue the Bay Area's commitment to reducing human impact on the environment. Urban growth boundaries were preserved to limit the rate of greenfield development in all three Futures. For the two higher-resource Futures, new revenues are relied upon to expand the amount of protected open space resources and to complete additional recreation trails and parks. New funding tools are also envisioned to upgrade a portion of the nearly 1.2 million pre-1970 residential buildings in the Bay Area that were built before modern safety, energy and water codes.

- Keep Current Urban Growth Boundaries in Place
- Expand Parks, Trails and Greenways, and Preserve Agricultural Lands
  - » This strategy was suggested for inclusion in Futures Round 2; however, it was not able to be modeled or analyzed as part of the scope of the assessment.

Reduce the Impact of Natural Disasters

Without mitigation strategies, the impacts of sea level rise combined with the simulated year 2035 Hayward Fault earthquake would impact hundreds of thousands housing units in the first round of Futures analysis. The impacts also damaged major segments of the Bay Area's transportation system. To reduce hazard and climate impacts and speed up the Bay Area's recovery following acute events, funding is dedicated to mitigate impacts and finance the Bay Area's rebuilding after a disaster. New revenues, described in the final section, would support these strategies.

- Modernize Existing Buildings With Seismic, Wildfire, Drought and Energy Retrofits
- Partially Adapt to Sea Level Rise
- More Fully Adapt to Sea Level Rise
- Adapt State Route 37 to Sea Level Rise
- Purchase Disaster Recovery Financing to Speed Recovery

Photo - MTC Archive

CHALLENGE

While much lower than prior decades, the Bay Area has continued to slowly build outward onto previously undeveloped lands. Expanding outward has negative environmental impacts and increases the amount of public infrastructure required to be built and maintained into the future. In Futures Round 1, this strategy effectively mitigated most of the impacts from urban sprawl.

STRATEGY

Maintain existing urban growth boundaries to restrict urban development on greenfield lands, continuing the Bay Area's recent commitment to reducing sprawl in undeveloped agricultural lands.

RATING: Recommended to move forward

The strategy has been an area of agreement among the ABAG and MTC governing boards in past Plan Bay Area cycles. In Horizon, staff opened up the door to consider greenfield development as an option. However, staff heard clearly from the public, stakeholders and elected officials that the Bay Area should remain committed to urban growth boundaries as a strategy to protect the environment and reduce urban sprawl, despite the need for new housing.

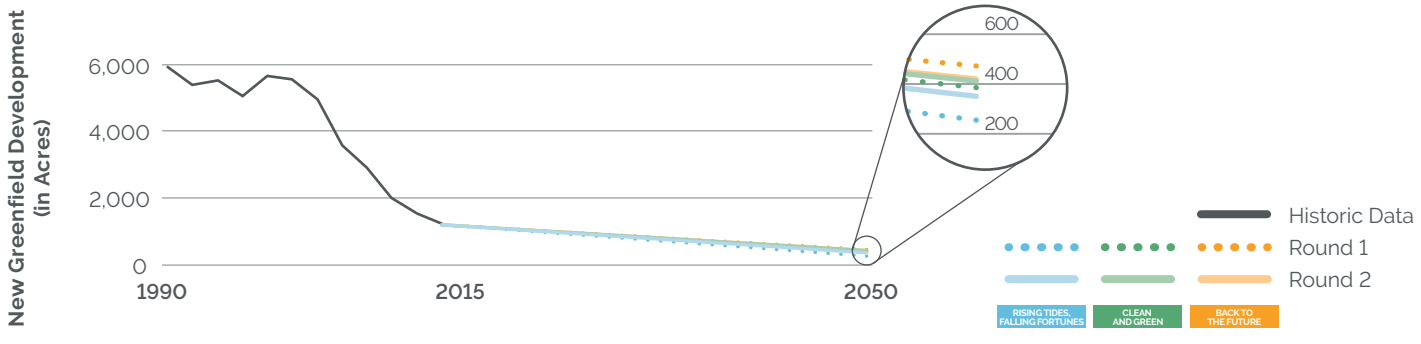
PROS

- **Urban growth boundaries reduce greenfield development**[US]**.** The strategy has been used in both previous Plan Bay Area cycles and in both rounds of Futures analysis. Figure 32 displays the recent regional progress in reducing greenfield development. With the policy in place, the projected greenfield development from 2020 to 2050 would be 33 to 47 times less than the recent 2000 peak.
- **There is broad public support to preserve urban growth boundaries.** In spring 2019 Horizon public workshops and as part of the Regional Growth Strategies Perspective Paper presentations, staff heard continued support for the Bay Area to prioritize infill growth over greenfield development in the future.

CONS

- **The strategy limits land available for development and increases land values.** As land values increase overall across the region, this can lead to higher development costs, especially if zoning is not adjusted to allow for new development options elsewhere within the urban growth boundary.
- **The strategy may be partly responsible for development spillover into the broader megaregion.** Increased development pressure that is unmet within the Bay Area can lead to development pressures in the megaregion resulting in greenfield development just on the other side of our county lines. Additional developments, similar to Mountain House in San Joaquin County, could occur if the Bay Area does not meet its regional housing needs in infill locations; these developments outside the Bay Area could generate additional traffic to and from the Bay Area.

Figure 32. Acres of annual greenfield development, historic and projected



TECHNICAL NOTES

To better understand this strategy's pros and cons, **the UrbanSim 1.5 land use model** was used to simulate the strategy, both individually and as part of a package. The UrbanSim model does not allow development to occur outside of locally adopted growth boundaries. The reason there is still greenfield development is because there are greenfield areas within the current set of urban growth boundaries that develop in the planning timeframe.

CHALLENGE

Many older buildings built before modern codes are at risk of damage in earthquakes and wildfires and do not meet current standards for energy and water efficiency. A significant earthquake or fire could create even greater pressure on the tight Bay Area housing market by reducing the available housing stock.

STRATEGY

Subsidize 50% of common earthquake, wildfire, energy and water retrofit strategies, splitting the revenues evenly among each issue area. In Futures Round 2, the subsidies were focused on older buildings built before current codes, tapping into synergies and efficiencies of doing upgrades together.

RATING: Recommended to move forward with minor adjustments

Seismic experts predict that there is a 72% chance of a magnitude 6.7 or greater earthquake occurring in the next 30 years. Furthermore, climate change is increasing the likelihood of wildfires in many Bay Area communities; adaptation measures could reduce damage from these types of impacts. The strategy supports upgrades in old multifamily buildings but could further be refined to ensure subsides are designed to specifically support renters and lower-income homeowners.

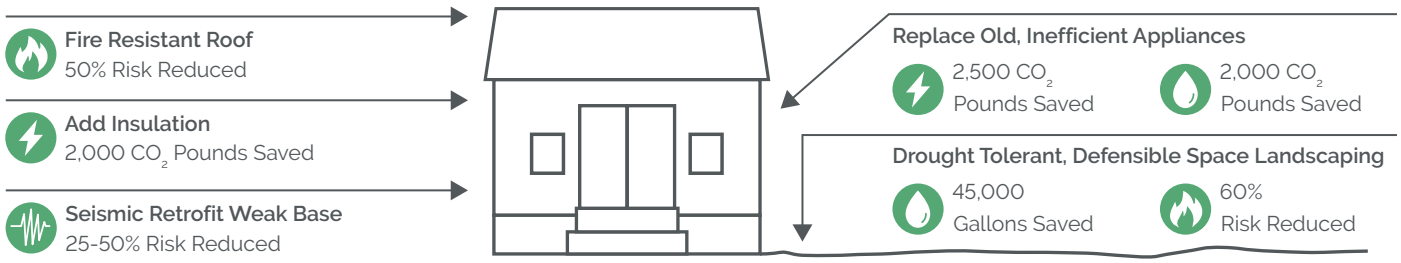
PROS

- **The strategy reduces residential earthquake damage by 25%**[US]. In Clean and Green and Back to the Future, the strategy reduces damage for 50,000 buildings, decreasing the number of homes that would need to be rebuilt and speeding overall recovery across the Bay Area.
- **Retrofits help to reduce wildfire risk for 275,000 homes.** Replacing roofs with fire-resistant materials and standards as well as ensuring 100 feet of defensible space have been shown to reduce wildfire risk by roughly half for homes in the wildland urban interface[96].
- **Energy and water efficiency upgrades reduce carbon and water footprints.** Completing common upgrades like adding insulation and replacing outdated appliances and water fixtures saves energy, reduces carbon emissions by 2 million tons, and reduces water use by 12 billion gallons annually.

CONS

- **Cost-burdened households could be strained by upfront costs.** In the long-run these strategies can reduce utility bills, reduce insurance rates and in the event of a disaster, reduce repair costs. A larger subsidy for lower-income residents or better financing could help mitigate upfront costs.
- **Earthquake and wildfire retrofits do not reduce the risk to zero**[US]. A retrofit reduces but does not eliminate risk; ideally, a retrofit is paired with insurance. The Bay Area and state should work to reduce insurance rates for lower-risk, retrofitted buildings and pass added savings to the owners.
- **Droughts may be more difficult to manage.** Water districts support water efficiency to make the water we have go farther, but they warn that as the number of water-intensive lawns shrink, our ability to curb demand in future droughts will be trickier and will require different management approaches.

Figure 33. Studied seismic, wildfire, drought and energy retrofit projects and their annual benefits



TECHNICAL NOTES

To better understand this strategy's pros and cons, an off-model approach was developed for wildfire, energy and water elements; **UrbanSim 1.5 land use model** was used to simulate the strategy, both individually and as part of a package. For earthquakes, UrbanSim characterizes the seismic fragility of each building based on the use, age and number of stories. The damage pattern uses the USGS 7.0 HayWired scenario. In Futures Round 2 analysis, buildings flagged as possible multifamily soft story or single-family cripple wall buildings are assigned a retrofit status halving their damage likelihood. The wildfire[97,98,99], energy[100,101], and water[102,103,104,105] estimations used literature review and off-model calculations.

CHALLENGE

With no protective measures, only 1 foot of sea level rise floods key highways, tens of thousands of homes and jobs, and the majority of the Bay Area's marshlands. The impacts grow larger and quicker with faster rates of sea level rise.

STRATEGY

Leveraging existing and new revenues, fund a set of protective and adaptive systems to prevent flooding in areas expected to have the most significant impacts. This set of measures prioritizes protecting existing communities, areas planned for future growth and key transportation systems. High-level project examples include eco-tone levees, sea walls and marsh restoration.

RATING: Recommended to move forward

The scale of unmitigated impacts to communities, the environment and the transportation network warrant adaptation action. MTC and ABAG will need to partner with others to consider how to knit together existing revenue sources and create new ones to support further advanced adaptation planning and funding for action.

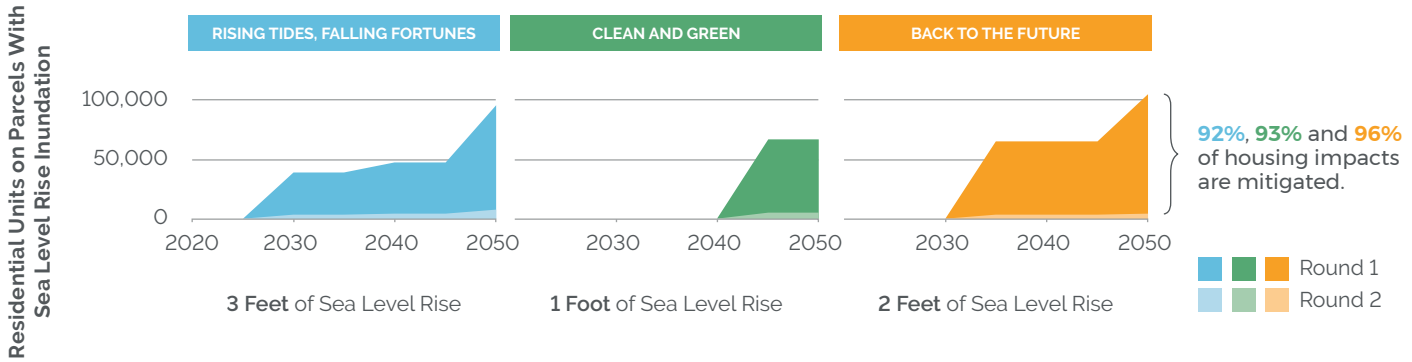
PROS

- **Adaptation measures prevent the loss of 60,000 to 100,000 housing units, employment sites with between 100,000 to 200,000 jobs, and key infrastructure such as highways and water treatment plants.** Communities across the Bay Area would remain housed, and core business centers would remain open. But without further adaptation measures, state Route 37 and Capitol Corridor rail lines would be underwater, and a portion of critical marshlands would be inundated.
- **This strategy creates opportunities for multi-benefit projects.** Sea level rise is a large challenge, but it offers opportunities for blended infrastructure projects that improve the quality of bayland ecosystems and complete gaps in public access, all while increasing the flood protection for communities.

CONS

- **Sea level rise adaptation is not a one-time cost.** Protecting communities and infrastructure from near-term flooding does not solve the problem forever. In decades beyond 2050, communities protected from flooding today would be at increasing risk later in the century. Similarly, segments or shoreline with limited risk today will need strategies once higher water levels occur.
- **Some communities are not fully protected from sea level rise.** The partial adaptation strategy allows some moderately impacted communities with more challenging long-term adaptation solutions to flood. For many flooded residents and businesses, the impacts would be severe.

Figure 34. Residential sea level rise impacts in Futures Round 1 (without adaptation) and Round 2 (with adaptation)



TECHNICAL NOTES

To better understand this strategy's pros and cons, **the UrbanSim 1.5 land use model** and **Travel Model 1.5** were used to simulate the strategy as part of a package. To model the impacts of sea level rise, staff tagged parcels and transportation assets that would flood using the BCDC Adapting to Rising Tides Bay Shoreline Flood Explorer maps. In Futures Round 1, UrbanSim 1.5 and Travel Model 1.5 would "turn off" flooded parcels and transportation links, redistributing impacted households, jobs and trips. In Futures Round 2, areas with the greatest flooding impacts were tagged as protected and not "turned off."

CHALLENGE

In some portions of the Bay Area, shoreline adaptation approaches may require extensive investment but may only protect a small set of individuals or lightly used infrastructure. Decisions on what can be protected with finite resources will be extremely difficult.

STRATEGY

Leveraging a larger set of new revenues, a greater number of protective and adaptive projects could be funded to expand the number of areas adapted in the "partially adapt" strategy. This larger set of adaptation strategies would protect a greater number of communities and fund large-scale marsh adaptation.

RATING: Recommended to move forward with minor adjustments

The "partially adapt" strategy protects areas with major impacts with a moderate level of investment. Other areas have significant but lesser impacts and may require massive capital investments to adapt the shoreline. As part of the Plan Bay Area 2050 Blueprint process, the Bay Area can begin to weigh the difficult decision of how much protective adaptation to fund.

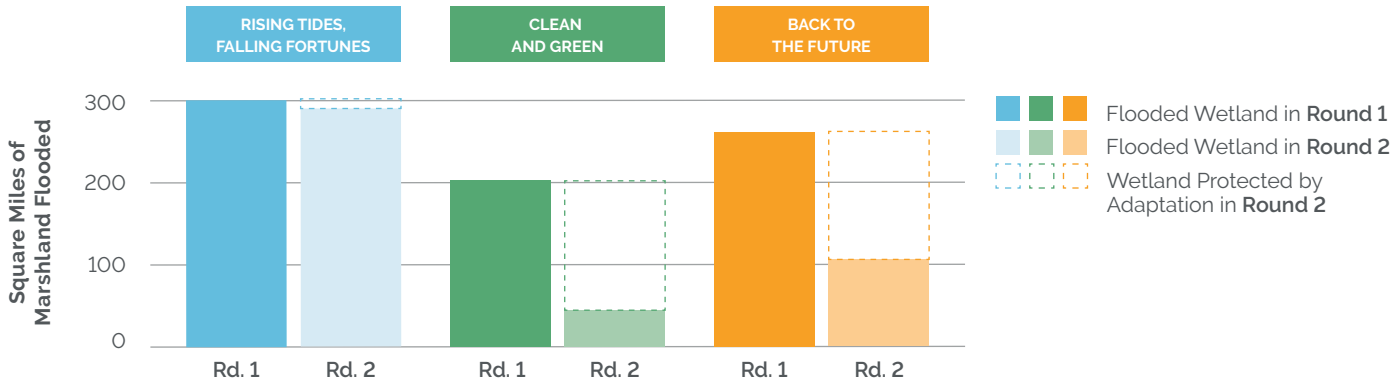
PROS

- **This strategy protects 2,000 to 3,000 additional homes compared to the "partially adapt" strategy.** More lower-density communities would be protected from sea level rise beyond those covered by a partial adaptation strategy.
- **Investments can expand natural ecosystem adaptation in large North Bay wetland ecosystems.** The North Bay offers potential for truly adaptive marshlands with room for the Bay's edge to retreat without significant impacts to communities. Figure 35 illustrates how a fuller adaptation studied in Clean and Green and Back to the Future supports greater ecosystem adaptation. Marsh systems provide carbon sequestration benefits, mitigate flood and erosion impacts, and are crucial to the larger Bay Area ecosystem health.

CON

- **Even the more fully funded adaptation strategies in Clean and Green and Back to the Future allow for some isolated flooding, generally in areas with very few residents.** As communities have adaptation conversations, there will be difficult choices to make about what is and is not protected. Even a prosperous region like the Bay Area does not have the resources to protect everything from continuous sea level rise. Adaptation to low levels of rise may be possible in many locations, but as seas continue to rise through the century, the Bay Area will have to weigh difficult decisions about where to protect and how.

Figure 35. Flooded and adapted lands in 2050



TECHNICAL NOTES

To better understand this strategy's pros and cons, **the UrbanSim 1.5 land use model** and **Travel Model 1.5** were used to simulate the strategy as part of a package. In addition to the modeling process described in the "Partially Adapt to Sea Level Rise Strategy," staff borrowed BCDC's Adapting to Rising Tides off-model analysis to describe natural land flooding. In Round 2 analysis, proposed marsh projects in EcoAtlas were supplemented with other large, hypothetical projects to understand how many acres of marsh would be at risk with and without action.

CHALLENGE

State Route 37 (SR-37) connects jobs in Marin County with housing-rich, yet often disadvantaged communities in Napa and Solano counties. Even today, low-lying areas of the highway flood most years, resulting in road closures lasting days or weeks. With rising sea levels, the frequency and duration of closures will increase, as will the expense and frequency of temporary and limited fixes.

STRATEGY

Replace 29 miles of levees and 17 miles of existing low-elevation roadway with a 17-mile elevated highway to accommodate future climate change and mobility challenges in the corridor, integrating the redesign with habitat planning, conservation and restoration projects to ensure healthy ecosystem function and resilience to landscape-scale change of San Pablo Bay.

RATING: Recommended to move forward with minor adjustments

The corridor provides a critical connection for North Bay communities as well as regionally significant wetland restoration and adaptation projects. Successful SR-37 adaptation will require an integrated approach that advances the full set of Guiding Principles. While this strategy has already linked mobility and ecosystem benefits, future refinements should focus on induced auto demand associated with providing additional highway capacity, as well as equity concerns associated with proposed tolls on the corridor. Means-based tolling, as well as strategic land use strategies, also warrant further consideration.

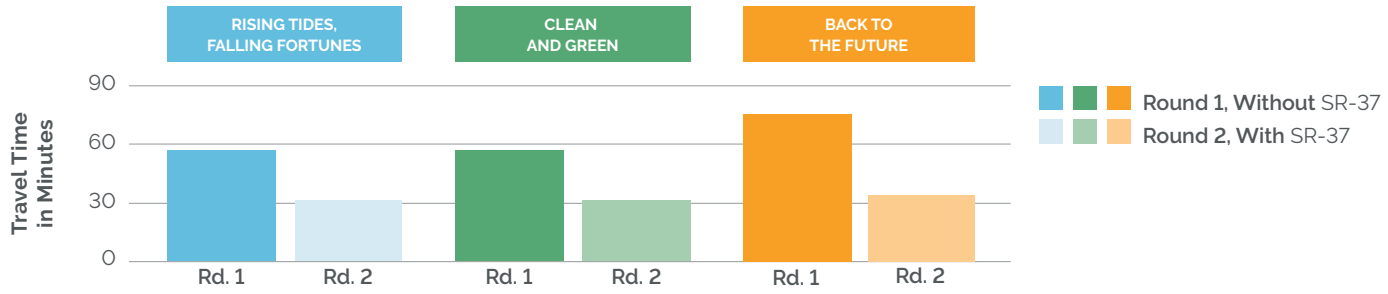
PROS

- **Investing in SR-37 maintains a key corridor in the North Bay.** Unlike other portions of the Bay Area, there is not an easily accessible parallel highway nor arterial road options. By adapting SR-37, accessibility remains for North Bay commuters going east to west. With an adapted SR-37 in place – rather than retreating from the project area — travel times between Novato and Vallejo would be 30 to 45 minutes faster. Relatively inconvenient parallel routes like the Richmond-San Rafael Bridge and SR-12 have 30 to 50 thousand fewer diverted trips.
- **A redesign of SR-37 facilitates extraordinary restoration opportunities.** Elevating SR-37 enables over 16,000 acres of marsh restoration along Sonoma Creek, the Petaluma River, Novato Creek and the Napa River. Raising the roadway and restoring the marsh are complementary strategies. With companion funding for marsh restoration, new and enhanced habitats can improve ecosystem health in a portion of the Bay Area with space for upward marsh migration.

CONS

- **As a long corridor nearly entirely at risk from sea level rise exposure, adaptation costs are very high.** Because most of the 17-mile corridor is at risk of inundation in the next 30 years and many of the adaptation costs grow based on linear distance, any option to protect this corridor would be high. In other portions of the Bay Area, highway impacts at 3 feet of sea level rise affect relatively short segments of freeways, resulting in smaller-scale projects and associated costs.
- **The SR-37 corridor has modest volumes compared to most Bay Area highways.** Mobility benefits on the SR-37 corridor are more limited because it has lower traffic volumes compared to major highways at risk from 3 feet of sea level rise, such as U.S. 101, SR-237, I-580, and I-880.

Figure 36. Travel time between Novato and Vallejo without (Round 1) and with (Round 2) SR-37



TECHNICAL NOTES

To better understand this strategy's pros and cons, **Travel Model 1.5** was used to simulate the strategy. This was a unique instance where a transportation strategy was run in isolation, using Project Performance modeling analysis. The strategy explored the effects of adapting and not adapting the state Route 37 corridor in the three Futures. In the Round 1 analysis, state Route 37 was removed, forcing different travel patterns.

CHALLENGE

In Rising Tides, Falling Fortunes, the federal government does not provide disaster recovery funding, leaving some highway segments and BART damaged through 2050 in the Round 1 analysis. In major disasters today, the federal government typically contributes 75% to rebuild damaged public infrastructure, but in 2019, new rules were proposed to reduce federal support in medium-sized disasters. If new federal guidelines develop, states and local governments will need new ways to finance recovery.

STRATEGY

The region or state purchases parametric catastrophe bonds that when triggered by an event, provide funding on the next day to pay for rebuilding. Catastrophe bonds are a type of insurance-linked security and are often used as companion financing to more traditional insurance.

RATING: Significant revisions needed for inclusion

The strategy was less helpful in Clean and Green and Back to the Future where the federal government was assumed to continue disaster recovery support. In 2019, this strategy may not yet be necessary; while the federal government may be considering a reduced role in disaster recovery, they have yet to back away.

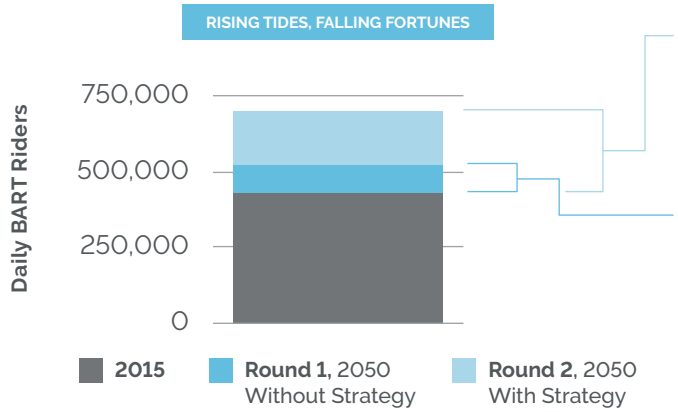
PROS

- **The strategy provides fast and reliable recovery financing to rebuild damaged infrastructure.** With a new funding source, the damaged highway and BART infrastructure that had remained damaged for 15 years in the Round 1 analysis in Rising Tides, Falling Fortunes could be repaired. With the transportation system fixed, BART ridership increased 33% from Round 1 and Round 2™.
- **Catastrophe bonds are a flexible form of recovery financing.** Other insurance-based financial tools are good vehicles to cover recovery financing, but most are tied directly to a specific asset. Catastrophe bonds instead pay out if an event of a certain size occurs; the funds can then be used to repair or rebuild whatever the user decides is most important.

CONS

- **Purchasing recovery financing at this scale would be expensive.** The Bay Area would have to purchase the coverage on an annual basis; the costs would be high with the coverage rate calculated based on the Bay Area's risk plus the private sector's profit margin.
- **Catastrophe bond flexibility is a double-edged sword.** Because the payout is not based on damage but instead on a defined event's occurrence, it is possible for a damaging earthquake, wildfire or flood to be just under the triggering threshold — leaving the Bay Area with zero financial resources to rebuild damage.

Figure 37. BART ridership increase in part as a result of repairing earthquake damaged lines in Round 2



In Round 2, overall BART ridership grew **63%**, with the strategy funding repairs after the earthquake. Because no other BART strategies (like a New Transbay Tube) were studied in **Rising Tides, Falling Fortunes**, the difference in ridership between Round 1 and Round 2 is largely a result of repairing damaged infrastructure.

In Round 1, overall BART ridership grew **22%**, despite damaged BART lines in southern and eastern Alameda County. While positive, this was substantially less growth than in **Clean and Green** and **Back to the Future Round 1** results which assumed BART damage was fixed.

TECHNICAL NOTES

To better understand this strategy's pros and cons, **Travel Model 1.5** was used to simulate the strategy as part of a package. The analysis of this strategy was largely an accounting exercise to price the strategy slightly above the amount of transportation earthquake damage in the HayWired scenario. In Round 1 analysis, damaged BART and highway segments were "turned off" in Rising Tides, Falling Fortunes between 2035 and 2050. In Round 2 analysis, the segments were repaired, reflecting the revenues to support recovery.

To reflect that many of the strategies had high capital or operating costs, revenue generating measures were modeled in the Futures Round 2 analysis. The new revenues were generated from four sources, chosen primarily because of their more progressive nature. The highway tolling strategy was one form of revenue generation and provided a substantial set of new revenues that were earmarked to fund the expanded set of transportation projects. The other three taxes were all equally applied with one-third of remaining revenue generated by a business tax, one-third by an income tax and one-third by parcel tax. In Rising Tides, Falling Fortunes, it was assumed that changes to each of these tax sources would raise roughly $300 million annually in 2019 dollars, creating nearly $1 billion annually in new revenue to support the complete set of "low-cost" budget strategies. In Clean and Green and Back to the Future, it was assumed that changes to each of these tax sources would raise $1.6 billion annually in 2020 dollars, creating nearly $5 billion annually in new revenue to support the complete set of low- and high-cost strategies studied in the Futures.

The analysis of these large tax measures was intended to provide a first step in acknowledging possible downsides associated with new revenue generation. Just as with all strategies studied in Horizon, the goal was to better understand the impacts, both positive and negative, of this "what if…" strategy. This early analysis of a major set of new revenue generating measures appears to have a limited effect on the strength of the Bay Area economy, as well as household incomes in the three Futures that were explored in Horizon. In fact, the economic model suggests that the revenue strategies, which fund an expansive set of social and infrastructure programs would increase the economy slightly. This reflects capital flowing to create new jobs, particularly in the construction and social services sector as previously seen in Figure 11 in Chapter 3. It does, however, decrease household incomes very slightly, no more than a tenth of a percent in any Future. Figure 38 and Figure 39 show the change in the gross regional product and average household income respectively without (Round 1) and with (Round 2) new revenues.

Photo - Karl Nielsen

Further analysis would certainly be warranted as new regional revenue measures are considered in the coming years. Additional benefits and drawbacks of new taxes could be integrated into the economic modeling, for example, better capturing the accessibility benefits associated with the new transportation projects or better capturing the county-by-county impacts that might vary more widely. Our finding from this analysis is simply that a thoughtfully crafted tax revenue measure could help to fund a suite of regional priorities, from infrastructure to affordable housing, without causing significant adverse economic impacts, at least in the three Futures explored in this report.

Figure 38. Projected average household income in 2050

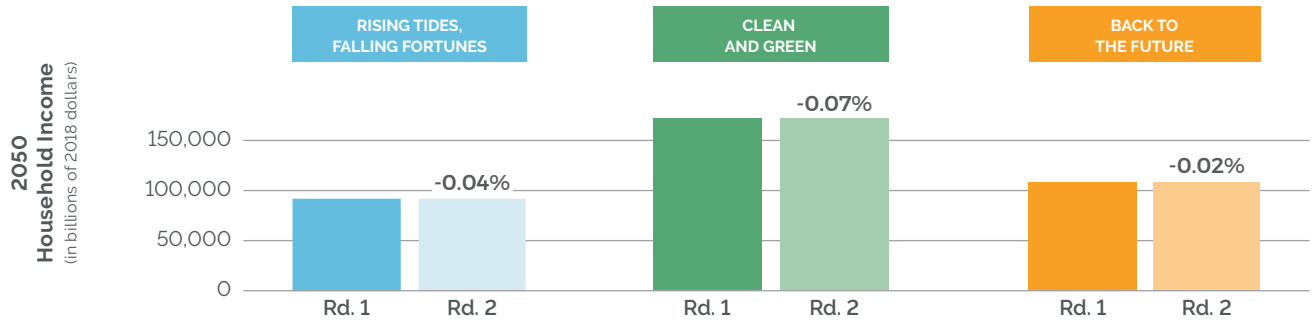
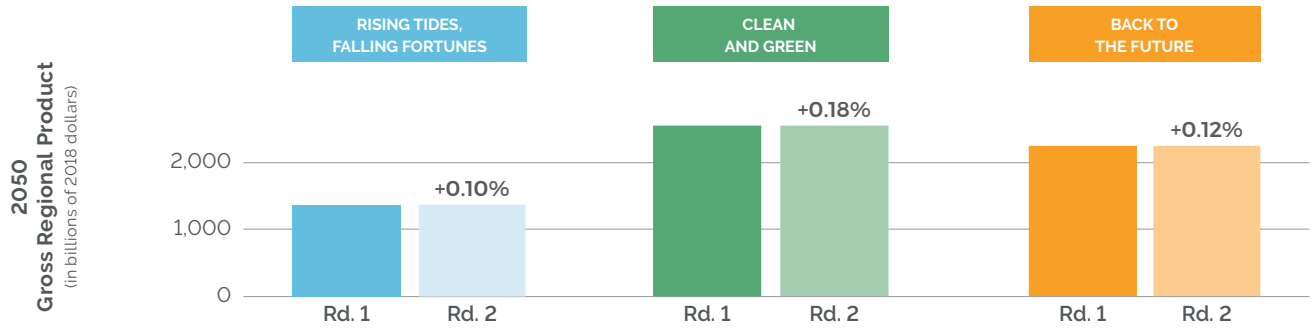
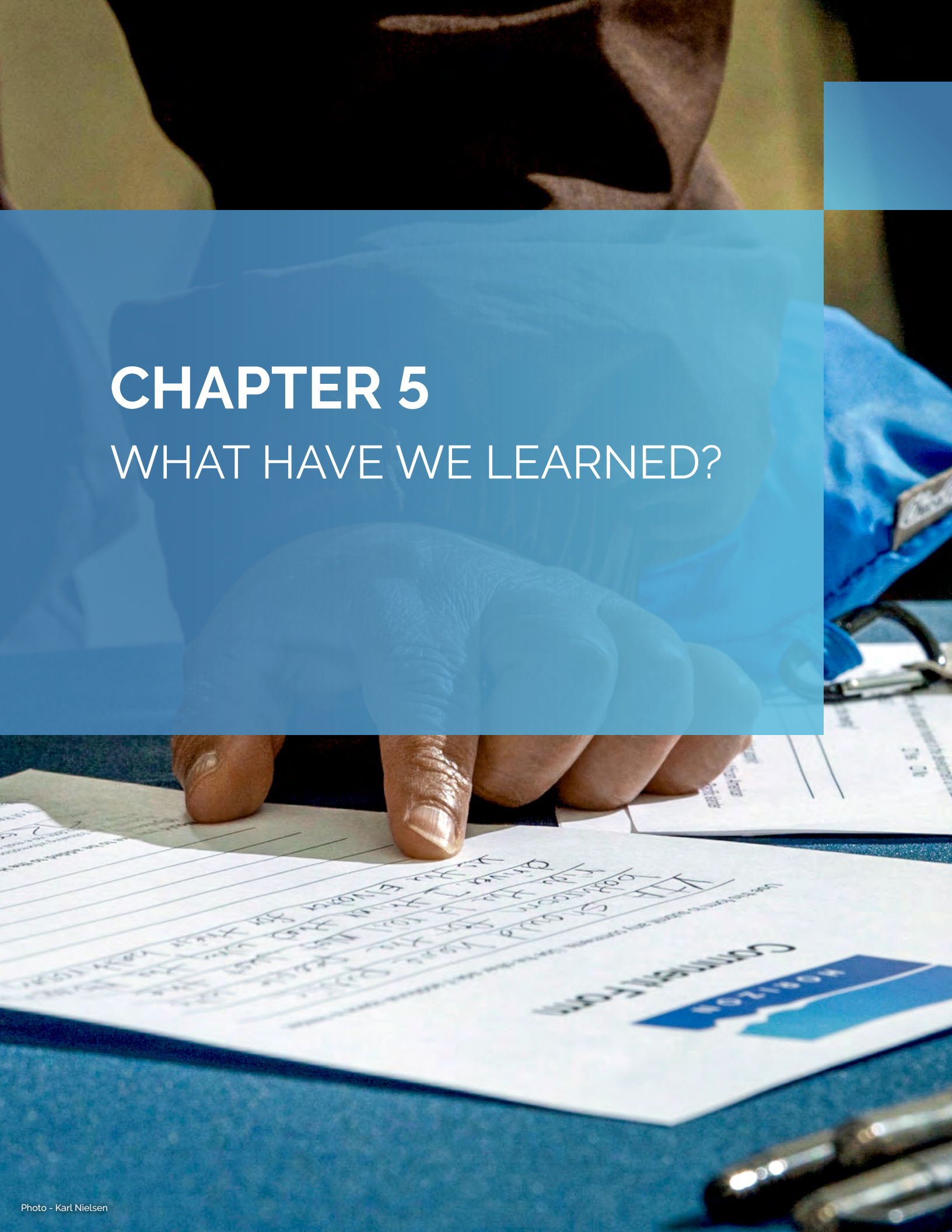


Figure 39. Projected annual gross regional product in 2050



TECHNICAL NOTES

To reflect that many of the strategies had high capital or operating costs, revenue generating measures were modeled using the **REMI 2.2 economic model**. When modeling the revenue generation measures, staff assumed each subregion within the Bay Area would provide the same share of property tax and income tax as their 2017 share using estimates from the State Controller Office and IRS. Property tax was added to both residential and non-residential properties in the REMI model, which in turn reduces personal income and increases business costs. The total income tax for each subregion was also increased, which further reduced personal income and purchasing power. To model the business tax, all industries in the region had a tax applied, which increased the production costs for all sectors within the Bay Area. In addition to these taxes, the highway tolling revenue was simulated in an economic model via a proxy of an equivalent gas tax increase, a lever available within the REMI model.



CHAPTER 5

WHAT HAVE WE LEARNED?

Photo - Karl Nielsen

WHAT HAVE WE LEARNED?

The Horizon initiative was designed to acknowledge future uncertainties and tackle them head-on in our planning. The first round of Futures analysis highlighted how varying rates of technology innovation, environmental change and economic conditions might shape the Bay Area through the year 2050. The divergent Futures led to both unique and common challenges, highlighting what the Bay Area should prepare for and how we may need to pivot in the years ahead. Many of the common challenges identified in the three Futures were a continuation of challenges that we face today and that persisted or worsened through the year 2050. Housing affordability, particularly for the Bay Area's lowest-income residents, worsened. The transportation system became increasingly congested and crowded with most trips continuing to occur in automobiles, regardless of levels of automation. Displacement remained a concern in all Futures, with the most prosperous future presenting clear income inequality challenges that led to the highest rates of displacement risk. Climate change impacts and environmental shocks stressed the health of the Bay Area's environment and its residents, and the regional economy continued to splinter with middle-wage jobs becoming a smaller share of all jobs, resulting in increased income inequality.

The second round of Futures analysis attempted to address these challenges. In total, 35 different strategies were explored to test their effectiveness against three different underlying conditions designed to highlight each strategy's strengths and weaknesses. Some strategies were identified to be very effective in improving outcomes under a variety of different external forces. Strategies that proved both effective and resilient, and particularly ones that advanced equity and the Guiding Principles that are now adopted by the MTC and ABAG governing boards, are strategies the Bay Area should seriously consider for inclusion in the Plan Bay Area 2050 Draft Blueprint. For strategies that had mixed results, or where goals were unmet, ABAG and MTC staff will work with partners to refine strategies and consider adjustments that may strengthen their effectiveness. Some strategies may benefit from strategic but limited changes, while others may require major revisions to address critical deficiencies before they can be considered for inclusion in the Draft Blueprint.

Findings in this Futures Final Report provide the Bay Area with a foundational analysis to start discussions on which strategies the Bay Area might consider if it wants to improve affordability, connectedness, diversity, environmental health and economic vibrancy. This report has also highlighted a need for ABAG and MTC staff to return to the drawing board with partners to figure out how to adjust strategies that did not have the desired effect or that presented concerning drawbacks. The Horizon initiative was the first step for ABAG and MTC to explore what the Bay Area can do to address current challenges, avoid future obstacles and leverage opportunities. We encourage the public, stakeholders and elected officials to consider the following takeaways as we advance into the Plan Bay Area 2050 process:

AFFORDABLE

CONNECTED

DIVERSE

HEALTHY

VIBRANT

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AFFORDABLE

Affordable housing strategies, particularly in the higher-growth and higher-resource Futures, increased the deed-restricted affordable housing stock significantly.

Achieving a greater share of affordable housing requires a package of aggressive strategies. The set of studied housing strategies may make substantial progress in building hundreds of thousands of additional deed-restricted affordable units across the Bay Area.

Strategies to expand housing development beyond the existing Priority Development Areas enabled many more homes to locate near transit, with a more limited effect on growth in High Resource Areas.

To realize greater transit access, a greater mix of housing must be allowed around a larger share of Transit Rich Areas. To realize a more inclusive Bay Area, a greater mix of housing, beyond what was studied in Horizon, must be allowable in High Resource Areas.

CONNECTED

Shifting the travel methods people use remains a key challenge, although opportunities exist through micromobility investments.

Reducing the number of automobile trips will be essential for the Bay Area to achieve its state-mandated GHG target in Plan Bay Area 2050. Strategies and external forces that increased the price of driving reduced auto trips, with investments in bike and pedestrian infrastructure resulting in further reductions.

Transit crowding challenges were alleviated in Futures Round 2, but some transit lines would need further action.

Across Futures, the number of households living near transit grew, resulting in ridership increases that exceeded existing transit capacity. Strategies that add capacity to existing service or enhance the viability of active modes as an alternative will be crucial to address transit crowding on major routes.

Traffic congestion declines slightly with new pricing measures and investments that prioritize optimizing existing highway capacity over expansion.

Automobiles remain the primary mode in the year 2050 in all three Futures, resulting in a significant increase in congestion. Strategies to optimize existing road capacity, reduce speeds and price highway use may make the roads safer and improve regional connectivity without increasing carbon emissions.

DIVERSE

By expanding the growth framework to include all High Resource Areas and increasing inclusionary zoning requirements, a slightly greater share of lower-income households locate in high-resource communities.

Expanding the growth framework to achieve both environmental and equity goals requires the Bay Area to consider defining new features of growth. The 2019 call for new Priority Development Area designations has already used the High Resource Area designation – to advance a more inclusive regional land use strategy, more housing, particularly affordable housing, is needed in High Resource Areas.

Displacement risk remained largely unchanged between Futures Round 1 and Round 2, with permanently affordable units appearing to be the best long-term solution to reduce displacement risk.

Displacement risk as measured by MTC and ABAG remains difficult to change, particularly in more affluent Futures. Permanently affordable, deed-restricted housing helps to ensure a baseline level of low-income housing in the region, particularly in areas with higher rates of growth where displacement pressures are often strongest.

HEALTHY

Resilience strategies can drastically lessen the climate and hazard impacts to the Bay Area's housing, transportation, and environmental and economic systems.

Investing in climate adaptation and hazard mitigation strategies greatly reduce damage to Bay Area housing and disruptions to the transportation network. To take proactive actions, the Bay Area will have to develop new revenues to advance these new strategies.

Bold actions will be needed to reduce the Bay Area's transportation greenhouse gas emissions.

New targets established by the state and likely future conditions identified in Horizon are making it increasingly challenging to achieve the greenhouse gas emission reduction goals in Plan Bay Area 2050. Electric vehicles can significantly help reduce GHG emissions, but do not advance the Bay Area toward other goals, such as reducing congestion and improving safety. To meet the GHG reduction targets and other goals, the region must advance transportation and land use strategies that prioritize the reduction of vehicle miles traveled and electrify the remaining VMT.

VIBRANT

Regional policies are likely to struggle in reversing a national-level trend in declining middle-wage jobs, which serve an important role in enabling economic mobility in an increasingly inequitable era.

New strategies aimed at growing the middle class had negligible regional effects. Partnering with the state and federal governments will be key to reverse the trend. Exploring strategies that reduce volatility in these jobs may reduce the damaging sector effects seen in the last recession.

Strategies that influence jobs location had mixed results; bolder strategies or new ideas will be needed to change the regional pattern of where future jobs locate.

The Bay Area has an overcapacity of areas zoned for commercial development – nearly every community wants more jobs. To see a radical shift in the location of jobs, cities across the Bay Area will need to adjust commercial development zoning and work with the business community to grow new job centers.

Photo - Karl Nielsen

What's Next?

ABAG and MTC staff are already hard at work transitioning from Horizon to Plan Bay Area 2050. In October and November 2019, staff went out across the Bay Area to hear from residents. At libraries, farmers markets, shopping malls and community events, staff listened to what Bay Area residents thought about some of the strategy concepts that have been recommended in this Futures Final Report. From November 2019 through January 2020, MTC and ABAG are hosting a series of workshops for local governments, partner agencies and interested members of the public, designed to help staff prioritize and refine strategies under consideration for inclusion in the Plan Bay Area 2050 Draft Blueprint.

MTC and ABAG invite all interested individuals and organizations to join the Plan Bay Area 2050 discussion to help craft a strategy-based Blueprint to address the Bay Area's big challenges in the years ahead. To learn about upcoming opportunities to engage in this discussion, please visit planbayarea.org to find out about upcoming events and meetings.

For questions about the Horizon planning process overall, feel free to contact Dave Vautin at dvautin@bayareametro.gov; for specific questions about the Futures Final Report, please contact Michael Germeraad at mgermeraad@bayareametro.gov.

Photo - Karl Nielsen

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APPENDICES

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APPENDIX A
ANALYTICAL MODELING TOOLS

The Futures Final Report is based on findings from analytic results and the output of computer modeling tools. Horizon builds on the past analytical work of Plan Bay Area and Plan Bay Area 2040, using Futures Planning as an opportunity to build out new computer modeling functions. At the heart of MTC and ABAG's analysis are three analytic stages: a regional-level economic and demographic analysis (REMI 2.1 and other tools), a land use model (Urban Sim 1.5), and a transportation model (Travel Model 1.5). The three analytic stages use data on the current conditions of the Bay Area and add in assumptions about future conditions to project what the Bay Area would look like in future years should those conditions occur. These analytic stages work together, with key data outputs from one phase passing on as inputs into the next one. Some information flows through feedback loops, but generally data outputs flow from the economic and demographic analysis, to the land use model, to the travel model. Figure A1 provides a simplified illustration of the inputs and outputs for each model, and the relationships between them. Below is more background information on the models, the upgrades to the models made as part of Futures Planning and the modeling assumptions for the key external forces.

Economic and Demographic Modeling

Development of population, employment and household forecasts for Horizon builds upon the framework established for Plan Bay Area 2040, applying the Bay Area version of the REMI model as well as the MTC and ABAG household and income distribution off-model analysis. Regional Economic Models Inc. (REMI) creates comprehensive economic models of regional economies, which the user can customize to reflect the unique characteristics of their area. For Plan Bay Area 2040, staff modified version 1.7.8 of the REMI model to capture the Bay Area's innovative position in a range of tech- and social media-based sectors as well as the baseline conditions of very high housing prices. Household numbers are driven from the demographic characteristics of the adult population, while income distribution considers industry and demographic trends. The REMI version 2.1 model and in-house modules were used to model the three divergent Future forecasts for the Bay Area. These forecasts were based on the external forces that undergird the Futures element of Horizon; external forces are defined as shifts on the global or national levels (beyond the control of the state or region) that affect the Bay Area's trajectory. For example, external forces include the rate of national productivity growth, the magnitude of global climate change and the level of immigration allowed by the federal government. These external forces were defined by stakeholders early in the planning process.

Key external force assumptions that vary for each of the three Futures drove the economic and demographic modeling outputs. These were:

- U.S. population growth rate,
- U.S. job growth rate,
- U.S. productivity growth rate,
- U.S. immigration rate,
- U.S. government spending level,
- U.S. tariffs and taxes, and
- The occurrence of a 2035 regionally significant earthquake.

The regional forecast consists of growth totals for the entire nine-county Bay Area, whose ultimate distribution to counties, cities, and parcels can be influenced by market conditions and policy interventions (e.g., zoning, subsidies, development requirements) in the UrbanSim 1.5 context. The regional growth forecast outputs become the inputs into the Bay Area UrbanSim 1.5 (discussed below), which then forecasts localized growth patterns based on the overall regional allocation.

Land Use Modeling

Bay Area UrbanSim 1.5 is a spatially explicit economic model that forecasts future firm and household locations. MTC and ABAG used a version of the Bay Area UrbanSim 1.0 model to inform the environmental assessment for the first Plan Bay Area (adopted in 2013) and both the Plan process and the environmental assessment for Plan Bay Area 2040, adopted in 2017. Bay Area UrbanSim 1.5 forecasts future land use change (e.g., development or redevelopment) starting from an integrated (across different source data) base year database containing information on the buildings, households, firms and land use policies within the Bay Area. Running in five-year steps, the model predicts that some households will relocate, and a number of new households will be formed or enter the region (as determined by the adopted regional growth forecasts developed above). The model system micro-simulates the behavior of both these types of currently unplaced households and assigns each of them to a currently empty housing unit. A similar process is undertaken for businesses. During the simulation, Bay Area UrbanSim 1.5 micro-simulates the choices real estate developers make on how much of, what and where to build. This adds additional housing units and commercial space in profitable locations (i.e., land use policies at the site allow the construction of a building that is profitable under forecast demand). In this way, the preferences of households, businesses and real estate developers are combined with the existing landscape of parcels and policies to generate a forecast of the overall land use pattern in future years. While forecast growth was constrained by base year policies in Futures Round 1, a number of policy modifications and new strategies were tested in Round 2. As detailed in the Chapter 4, these strategies included increases in allowable residential development density, requirements for the construction of inclusionary housing and preventative measures against natural hazards. In each of these cases, Bay Area UrbanSim 1.5 responds by forecasting a different land use pattern consistent with the constraints or opportunities resulting from the change. For each period, the model produces a zonal output file for the travel model that contains household counts by income and employee counts by sector. This provides the travel model with information on land use intensity in different locations and the spatial distribution of origins and destinations within the Bay Area. Key improvements between Bay Area UrbanSim 1.0 and Bay Area UrbanSim 1.5 include the following:

- New modeling features that allow for simulation of natural disasters and sea level rise,
- New policy levers to mitigate natural hazard impacts,
- Improved implementation of accessibility changes from Travel Model 1.5 into land use pattern shifts,
- Ability to change core model parameters across scenarios to represent shifts in preferences, and
- Additional household segmentation for relocation rates.

The following key external force assumptions were incorporated into the model and influenced the land use modeling outputs:

- The preference of households to locate in lower or higher density areas,
- The cost of development associated with changing needs for parking provision in Futures with sharing preferences and autonomous vehicles,
- The proliferation of e-commerce to redevelop aging malls and redistribute the locations of firms,
- The occurrence of a 2035 regionally significant earthquake, and
- The occurrence of sea level rise inundation.

Travel Modeling

Travel Model 1.5 is a regional activity-based travel model for the Bay Area. This model is a series of simulations that predict Bay Area residents' responses to transportation projects and policies. In addition to exogenous variables highlighted below, Travel Model 1.5 takes land use inputs from UrbanSim 1.5 for the location of housing and jobs by travel analysis zone (TAZ). Key improvements between Travel Model 1.5 and the version that was used for Plan Bay Area 2040 (Travel Model 1.0) include the following:

- New modeling features that allow for simulation of natural disasters and sea level rise,
- New policy levers to mitigate natural hazard impacts,
- Improved implementation of accessibility changes from Travel Model 1.5 into land use pattern shifts,
- Ability to change core model parameters across scenarios to represent shifts in preferences, and
- Additional household segmentation for relocation rates.

Key external force and exogenous assumptions that affected travel modeling configuration for future modeling years in Horizon included:

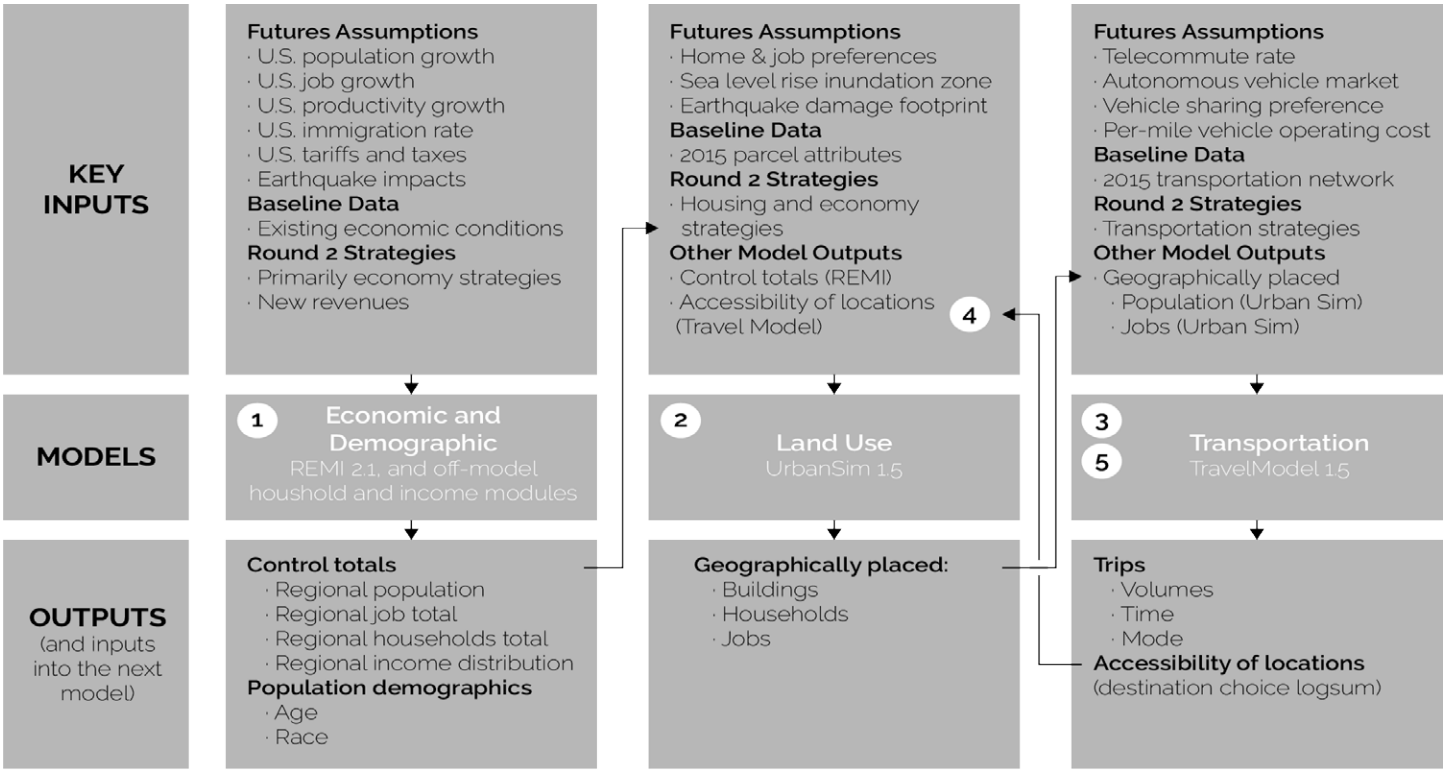
- The assumed telecommute rate,
- Different levels of autonomous vehicle penetration, the impact they have on roadway capacities and travelers' in-vehicle travel time sensitivities,
- TNC fares and passenger occupancy,
- Zero passenger vehicle travel by TNCs and autonomous vehicles,
- Sharing preferences,
- Per-mile operating costs,
- The occurrence of a 2035 regionally significant earthquake, and
- The occurrence of sea level rise inundation.

Modeling Process – Highlighting the Land Use and Transportation Feedback Loop

While most model data flows sequentially as described from the REMI and companion household and income models to UrbanSim 1.5 to the Travel Model, the effects of transportation projects and policy were incorporated into UrbanSim by means of a feedback loop (steps 4 and 5). For both Round 1 and Round 2 analysis, the modeling process included the following steps:

1. **Run REMI.** Create regional forecasts of households, population and employment growth in the nine-county Bay Area using REMI and companion household and income model.
2. **Run UrbanSim 1.5.** Use the regional forecasts from step 1 as UrbanSim 1.5 inputs. UrbanSim 1.5 then forecasts the locations of households and jobs within the Bay Area through 2050.
3. **Run Travel Model 1.5.** Use the 2050 population and employment distribution outputs from step 2 as Travel Model 1. 5 inputs. Also apply updated 2050 transportation network and policies reflective of the Future and analysis round. Document the new accessibility values for each area in the Bay Area in 2050.
4. **Re-run UrbanSim 1.5.** Using the new accessibility values from step 3, update the year 2030 Urban Sim 1.5 accessibility inputs. This is meant to account for effects of transportation on land use; that is, transportation networks and policy (and their resulting accessibilities) influence the desirability and profitability of real estate development. The accessibilities are input into an earlier year to model that accessibility changes are anticipated ahead of when they are on the ground.
5. **Re-run Travel Model 1.5.** Update the Travel Model 1.5 inputs with the new 2050 population and employment distribution from step 4. Re-run with the same 2050 transportation networks and transportation policies included previously.

Figure A1. Modeling inputs and outputs and the modeling process flow



APPENDIX B
REGIONAL MAPS – INTERPRETING SUPER DISTRICTS

Many of the maps in Chapter 3 summarize modeling results by super district. MTC uses super districts to depict trends at a sub-regional scale to illustrate differences between north, south, east and west portions of counties. The figure and table below show which jurisdictions are included in each of the 34 super district zones.

Figure B1. Map of super district geography

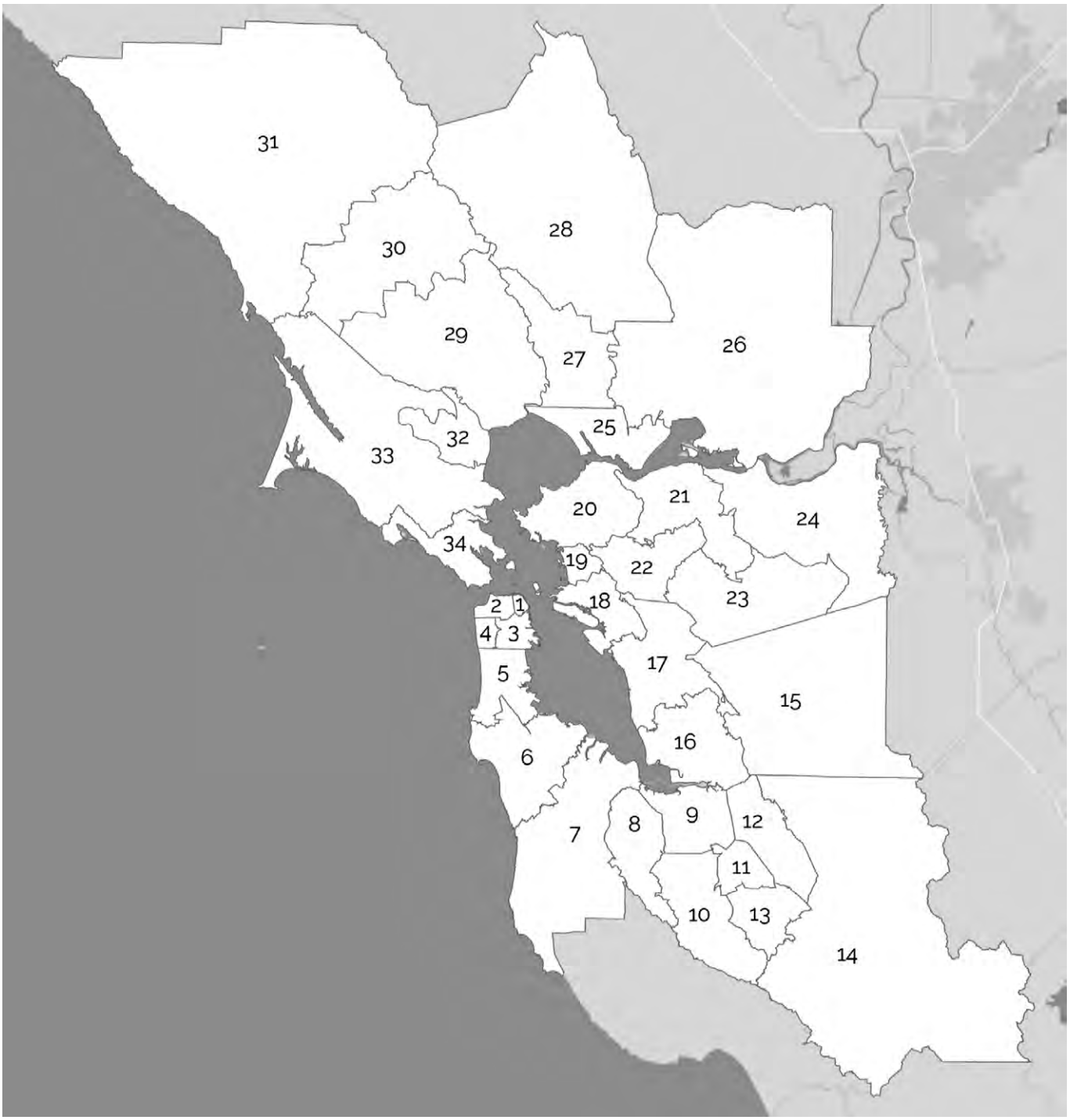


Table B1. List of jurisdictions in each super district

County	Super District	Jurisdiction
San Francisco County	1	San Francisco - NE
	2	San Francisco - NW
	3	San Francisco - SE
	4	San Francisco - SW
San Mateo County	5	Brisbane
	5	Colma
	5	Daly City
	5	Millbrae
	5	Pacifica
	5	San Bruno
	5	South San Francisco
	6	Belmont
	6	Burlingame
	6	Foster City
	6	Half Moon Bay
	6	Hillsborough
	6	San Mateo
	7	Atherton
	7	East Palo Alto
	7	Menlo Park
	7	Portola Valley
	7	Redwood City
	7	San Carlos
	7	Woodside
Santa Clara County	8	Los Altos
	8	Los Altos Hills
	8	Mountain View
	8	Palo Alto
	9	San Jose *(portion)*
	9	Santa Clara
	9	Sunnyvale
	10	Campbell
	10	Cupertino
	10	Los Gatos
	10	Monte Sereno
	10	Saratoga
	10	San Jose *(portion)*
	11	San Jose *(portion)*
	12	Milpitas
	12	San Jose *(portion)*
	13	San Jose *(portion)*
	14	Gilroy
	14	Morgan Hill
	14	San Jose *(portion)*
Alameda County	15	Dublin
	15	Livermore
	15	Pleasantton
	16	Fremont
	16	Newark
	16	Union City
	17	Hayward
	17	San Leandro
	18	Alameda
	18	Oakland
	18	Piedmont
	19	Albany
	19	Berkeley
	19	Emeryville

County	Super District	Jurisdiction
Contra Costa County	20	El Cerrito
	20	Hercules
	20	Pinole
	20	Richmond
	20	San Pablo
	21	Clayton
	21	Concord
	21	Martinez
	21	Pleasant Hill
	22	Lafayette
	22	Moraga
	22	Orinda
	22	Walnut Creek
	23	Danville
	23	San Ramon
	24	Antioch
	24	Brentwood
	24	Oakley
	24	Pittsburg
Solano County	25	Benicia
	25	Vallejo
	26	Dixon
	26	Fairfield
	26	Rio Vista
	26	Suisun City
	26	Vacaville
Napa County	27	American Canyon
	27	Napa
	28	Calistoga
	28	St Helena
	28	Yountville
Sonoma County	29	Cotati
	29	Petaluma
	29	Rohnert Park
	29	Sonoma
	30	Santa Rosa
	30	Sebastopol
	31	Cloverdale
	31	Healdsburg
	31	Windsor
Marin County	32	Novato
	32	Fairfax
	32	Ross
	32	San Anselmo
	32	San Rafael
	32	Belvedere
	32	Corte Madera
	32	Larkspur
	32	Mill Valley
	32	Sausalito
	34	Tiburon

APPENDIX C

TRANSPORTATION PROJECT LIST FOR CAPACITY-INCREASING INVESTMENTS

Table C1. Transportation project list for capacity-increasing investments

Strategy	Strategy Title	Project Title (*for strategies with multiple projects)*
PBA-4	Make Strategic Modernization & Expansion Investments for Public Transit	AC Transit Local Service Frequency Increase Sonoma Countywide Service Frequency Increase Muni Forward + Service Frequency Increase New BRT Lines: San Pablo, Geary (Phase 2), El Camino Real BART Core Capacity BART to Silicon Valley (Phase 2) Caltrain Downtown Extension Vasona LRT (Phase 2) Eastridge LRT Extension WETA Service Frequency Increase WETA Ferry Network Expansion Downtown San Francisco & Treasure Island Congestion Pricing Bay Area Forward (Phase 1) Better Market Street
PBA-5	Build Carpool Lanes and Address Interchange Bottlenecks	Regional Express Lanes *(converted to carpool lanes w/pricing)* I-680/SR-4 Interchange + Widening (Phases 3-5) SR-4 Operational Improvements I-80/I-680/SR-12 Interchange + Widening (Phases 2B-7)
PBA-6	Operate and Maintain the Existing System	
C-1	Develop a Single Platform to Access and Pay for All Mobility Options	
C-3	Build a Complete Micromobility Network	Bay Trail Completion Bicycle Superhighways Feeder Network on Local Streets
C-4	Build a Next-Generation Bus Rapid Transit Network	Regional Express Bus Network Optimized Express Lane Network Gap Closures
C-6	Apply Time-of-Day Tolls on All Highways	
D-4	Invest in Free Short-Trip Service	Bike Share System Expansion and Free Bike Share Autonomous Shared Shuttle Service
NEW	Implement Vision Zero Speed Reduction Measures	
C-7	Build a New Transbay Rail Crossing	
C-9	Extend the Regional Rail Network	BART DMU to Brentwood SMART to Healdsburg Dumbarton Rail Valley Link (Tri-Valley to San Joaquin Valley) SMART to Richmond via New Richmond-San Rafael Bridge
C-10	Increase Existing Rail Capacity and Frequency by Modernizing the Network	VTA LRT Automation and Grade Separation Caltrain Frequency Increase (10 Trains per Hour) Muni Metro Southwest Subway
A-3	Provide Free Transit to Low-Income Riders	